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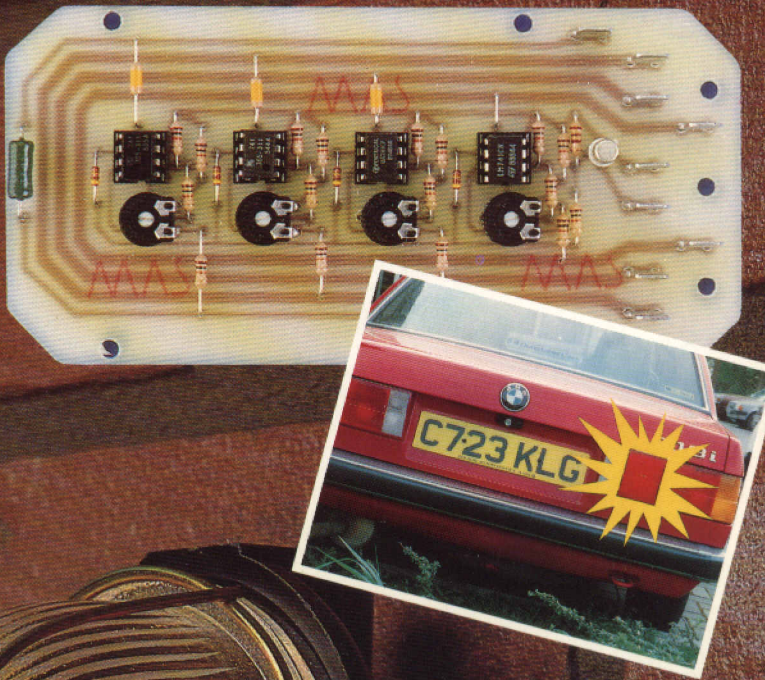
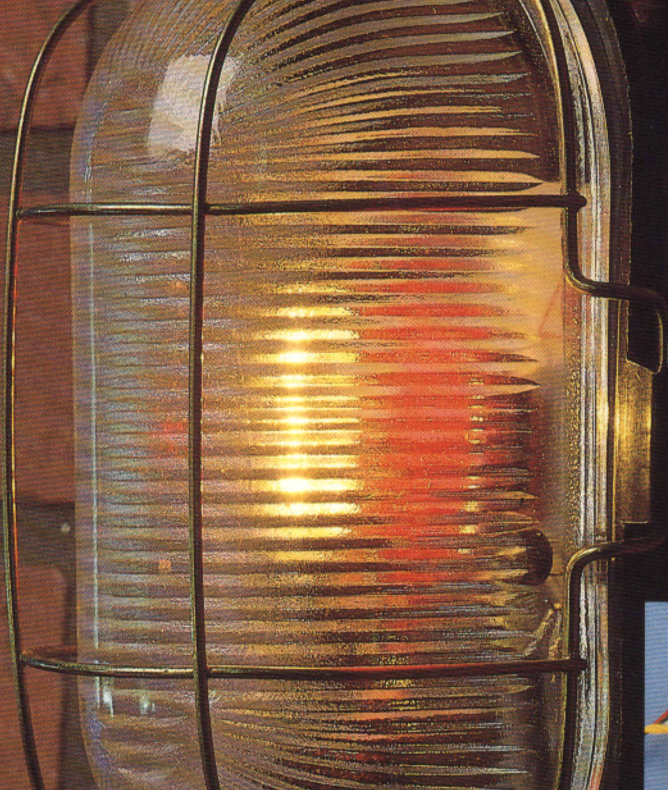
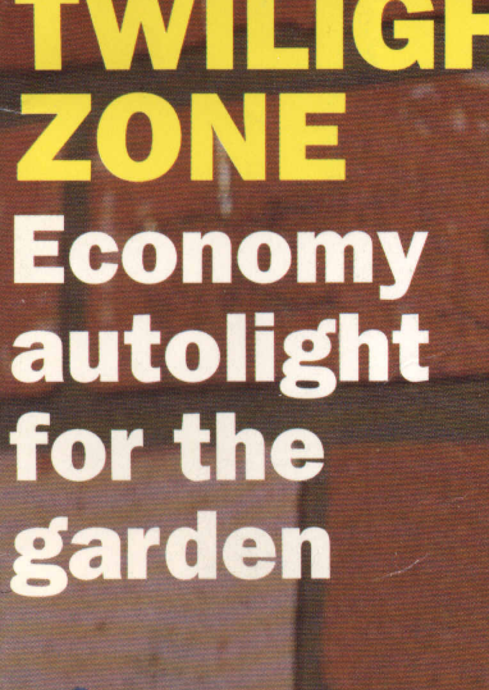


TWILIGHT ZONE
Economy autolight for the garden



LUMITEC
An easy way to monitor car lamp failure



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Volume 22 No.8
August 1993

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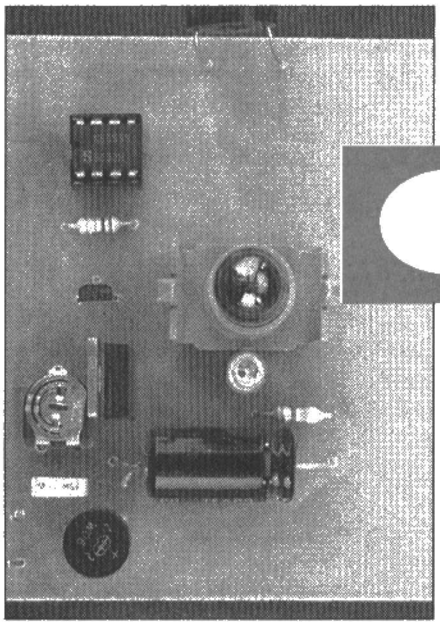

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Editorial

by Paul Freeman

With joint venture co-operation from the multinationals breaking out all over the place these days, it seems that complete market domination is their aim.

IBM and BT have been collaborating on a project to make the videophone a standard appliance by the end of the century, IBM providing the software and BT the communication technology.

As most people now have Windows on their computer screens and a separate telephone, the videophone will just become another integrated part of the system. Using digital ISDN lines, costing no more than an ordinary phone call a good colour image appears on screen. Improving the moving image is just a case of using two lines instead of one. Multiway link-ups or video conferencing should also become common place. The two giants see this situation as an inevitability, as they already have companies beating on their doors for the technology. The reasons are clear - cutting down travel time and saving costs would appeal to any company.

The technology is here and the videophone described will be available from around October. Whether there will be intense advertising pressure to make the consumer believe they cannot do without one, or whether computer buffs will want the latest gadget irrespective, remains to be seen.

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OPEN CHANNEL

Any doubts anyone has ever had about the long-term viability and popularity of satellite television must surely be quashed with British Telecom's recent move into the telecommunications consumer sales arena. By the end of the year, BT will be selling satellite receivers and dishes (Astra-based, of course) from its 90 shops around the country.

Astra's operator, the Societe Européene des Satellites, is not in the least surprised. Other household names are expected to follow BT's lead over the next year or so, as sales in general ramp up and more people take advantage of the wide range of high quality programmes now on offer from the Astra series of satellites.

There are now two Astra satellites in service, while a third - Astra 1C - was successfully launched aboard Arianespace flight number 56 during the early hours of May 12 this year. Indeed, as you read this, Astra 1C will be in the engineering process of being made operational, and several transmissions may already have started from it. Three satellites co-located at the Astra position of 19.2' east of south means that some 50 television channels (16 on each of Astras 1A and 1B, and 18 from Astra 1C) are now possible, along with hundreds of radio channels, and all can now be received from just one dish pointed at the satellites' single position.

BT has simply seen the writing on the wall, of course - or probably more to the point, the dishes on the walls - with this move to act as a retail outlet, but it does signal a general change in attitude towards satellite television reception. Just a few years ago, the only satellite dishes around were large multi-satellite affairs in the occasional enthusiast's gardens. While these are still around (and indeed, have become more popular due to Astra's involvements) the norm is now to see dishes on house walls pointed towards Astra. In these few short years, satellite television has changed from being a novelty and an amusement to neighbours, into being almost the norm.

By retailing receivers and dishes, BT has simply underlined the general and growing acceptance of satellite television reception and, thus, can only be good for the already flourishing market. In a few year's time, it may be to the amusement of neighbours if a house doesn't have a satellite dish on its wall.

Virtually reality

It's not often that a new product or service comes along which I think could be a winner. Five years ago, the birth of reasonable satellite television suggested one such service. And now look at it.

The latest development to look promising in my eyes is a service called virtual private networking (OK, if you have to have an acronym - VPN). Actually, the service has been around in one form or another since 1984, but it's only recently that world-wide moves have been made to make it of interest outside of pure data communications fields among restricted groups in the United States. Things are changing, as more users see its potential.

A virtual private network is a method of allowing data communications between distributed sites, such that each data user on the network appears - via a computer - to be directly connected to the other users, despite the distance between them. So, it works in much the same way as local area networks, such as LocalTalk or Ethernet, around a single office, in that data can be freely routed between users and users can communicate equally freely. It's just that distances of many thousands of miles might be involved, rather than the few metres within an office.

There's nothing new in principle here - after all, a few modems can be interlinked over standard 'phone lines to give a similar, if not the same effect. The trick is to do it all so that each user appears to be directly connected to the others, as if a private long distance network of cables between sites had been set-up.

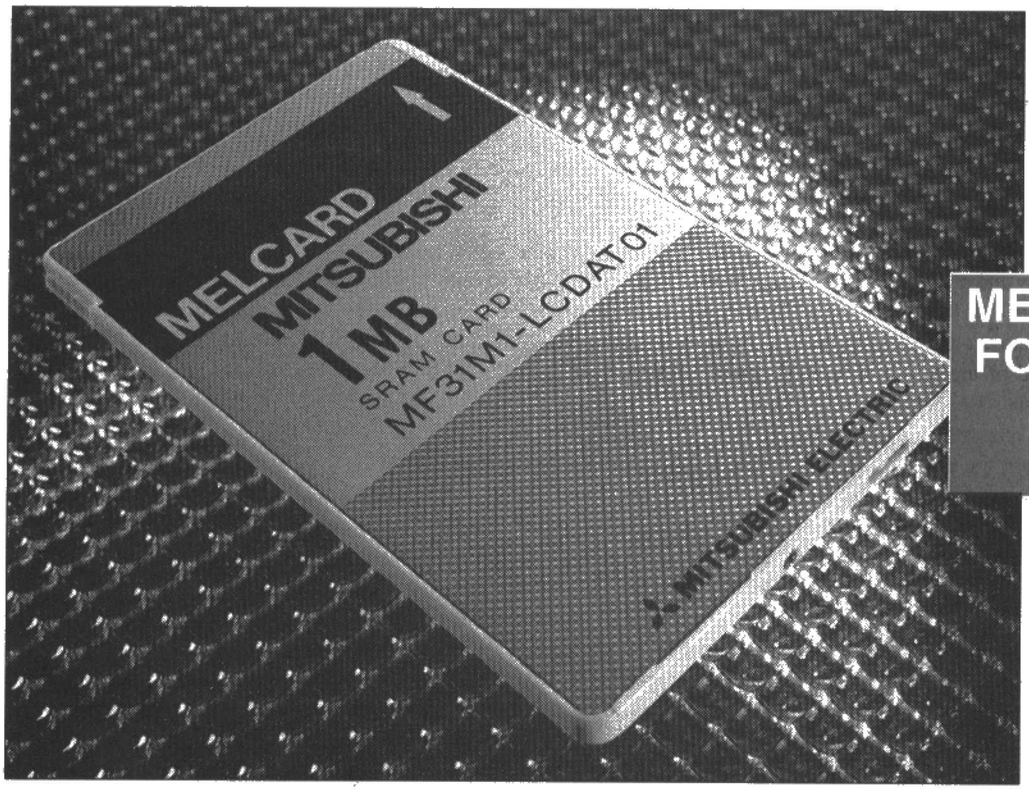
The advantage to users, over a true private network, is in cost - private networks are very expensive. Merely using the 'phone network to interconnect users as and when required is cheaper and, potentially, much cheaper. Private networks are expensive to install (lots of cables) and run, while telephone lines are already there and are already being run. Private networks require expensive hardware, which inevitably has to be paid for directly by the users, while virtual private networks only require additional software in the switching exchanges which set-up the required links over the existing 'phone network. Effectively, this software simply has to set-up a predefined linkage, in a very similar way to that in which standard 'phone calls are set-up.

To date, the only obstacle in the way of decent and world-wide virtual private networks has been the disparity between telephone network operators. The services which one operator, in one part of the world, provides may be somewhat - if not totally - different to the services provided by another elsewhere. So, what looks to be a good thing, has been held back by lack of standardisation.

Fortunately, things appear to be changing. Telephone operators around the world (some 25 so far) have joined forces to define standard features which should be offered and to fix a seamless method of integrating world-wide services. This is just the start. Once virtual private networks become more common (which they will - simply because of this standardisation and cost benefit) price cuts are inevitable. It's foreseeable that the long-awaited and much-vaunted revolution in teleworking (i.e., working at home, instead of in an office and simply linking to the office computer by 'phone line) will be able to finally happen. Virtual private networks will allow this easily and, what's more, at an ever decreasing cost.

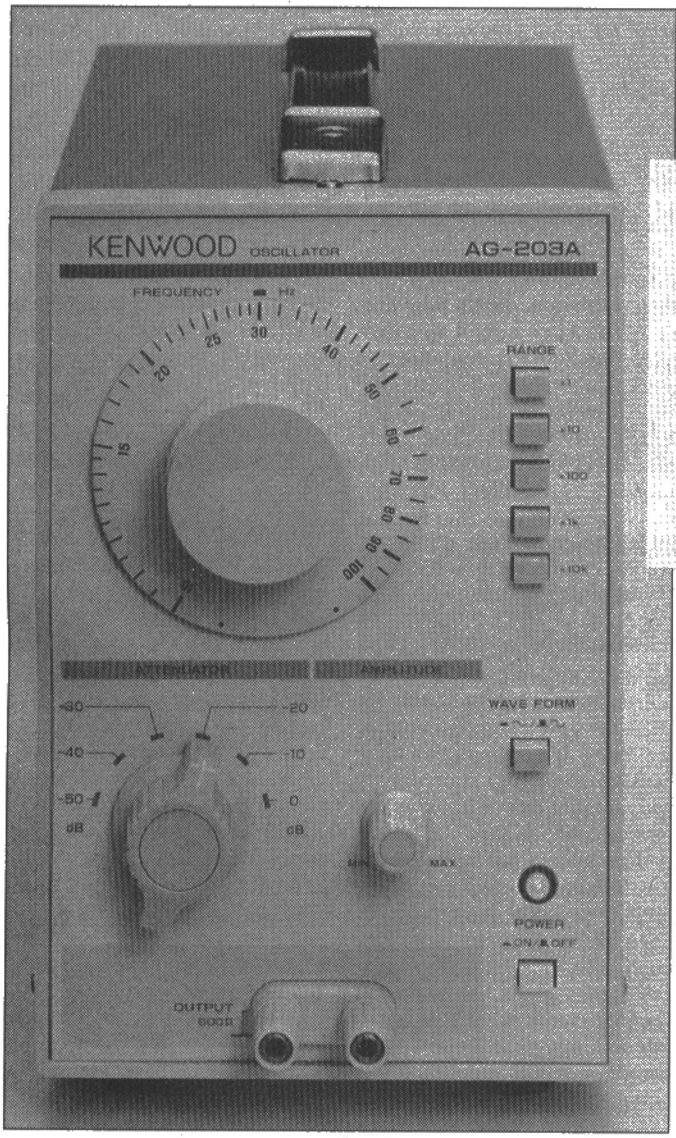
Keith Brindley

MEMORY CARDS FOR PERSONAL DIGITAL ASSISTANT



Mitsubishi has announced the release of its JEIDA and PCMCIA Standard SRAM memory cards, the first to be approved by Amstrad for use with the computer company's new personal digital assistant. The memory cards are used by the computer to provide additional memory for storing text, names, addresses and notes, and 128k, 256k, 512k, 1M, and 2M versions are now available from Amstrad Spares & Service Division at Brentwood. A 4Mb SRAM card is also available from Mitsubishi.

The SRAM memory cards come in JEIDA and PCMCIA 68 pin format. A double battery backed SRAM version to JEIDA Standards can also be supplied.



LOW DISTORTION SIG GEN

Trio-Kenwood has introduced the AG 203a audio oscillator, which produces low distortion sine and square waveforms with the frequency range of 10Hz to 1MHz.

The sine wave signal is typically better than 0.1% distortion with an output flatness of +0.5dB. The square wave signal has a maximum rise time of 200ns with a duty cycle of 45-55 at 1kHz.

Frequency is selected by a series of range switches with fine adjustment by a rotary vernier control. An output attenuator provides up to -50dB reduction from a maximum output level of 7V RMS. The output impedance is 600R.

The AG 203a is priced at £155.00 + VAT.

60 YEARS OF INNOVATION

Dr William Percival, a prolific inventor with over 120 patents to his name, is this year celebrating sixty years furthering British science and technology in the field of electronics. At 89 years old, he is still heavily involved in technological innovation as a consultant and adviser at Central Research Laboratories Ltd (CRL) - formerly the research development centre of THORN EMI plc - where he has been employed as a scientist since 1933.

Dr. Percival's route into electronics began during the early days of radio with research in crystal detection and technical journalism for Wireless Weekly, Wireless Construction and Modern Wireless. On joining EMI's research laboratories, Dr Percival became a member of the celebrated 'Blumlein' research team, working alongside one of the most influential scientists of this century, A. D. Blumlein, on the first public TV broadcast system at Alexandra Palace in 1936.

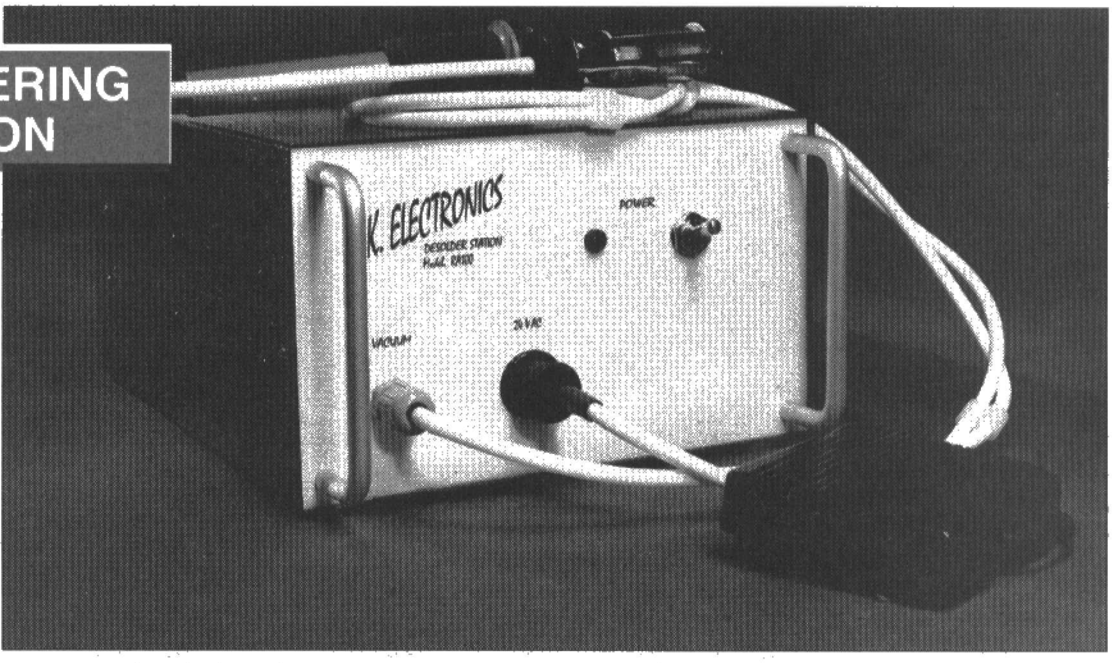
Following the success of the first broadcasts, television circuitry became very popular. The 'hook' phenomenon which caused a television picture to drop away was solved by Dr Percival using frame pulses as line pulses.

During World War II, Dr Percival worked on the world's first RADAR systems and developed particular expertise in aerials for 3cm and 10cm RADAR. Percival explains RADAR's origins: "We noticed that every time a plane flew overhead, the picture quality on the television was affected. We deduced that if we analysed the variation in picture quality, we would detect the presence of a plane. Distance and direction could then be gauged measuring the time it took for the signal to travel from a plane to receptors and by using directional equipment such as rotating aerials."

Another past project was the creation of high power transmitters for TV via distributed amplifier and transversal (Kalman) filters. These were used in early transmitters to broaden bandwidth and allow more information. Dr Percival also completed mathematical analysis to assess the imaging techniques incorporated into the original X-ray scanner, for which CRL's Sir Godfrey Hounsfield won the Nobel prize in 1979.

Some of Dr Percival's most recent achievements have focused on audio broadcast technologies including ICE, the first system to inaudibly embed security data into music. ICE enables the identity of broadcast music to be monitored off-air automatically and is set to become the industry standard for music identification.

DESOLDERING STATION



With the ever increasing complexities in the Electronics industry, one of the growing problems is removing devices with a large number of pins. The days of removing these devices with a hand desolder pump are getting further and further away. Boards with line tracks are easily damaged with excess heat from the soldering iron or by slipping with the hand desolder pump.

With the cost of integrated circuits rising, it is important to remove components so that no damage is done, either to it or the printed circuit board and it was with this in mind that the RA100 Desoldering Station was designed by AK Electronics of Edgware. It was intended to produce a low cost unit, with low maintenance and inexpensive spares, but still with a good vacuum. The vane pump used for this operation develops 15in of mercury vacuum and should cleanly remove solder from plated through boards. The wiring loom was specifically designed with push on crimp connectors to enable the user to carry out repairs on site, without the need to return the unit for repair.

The RA100 was designed around the Weller DS3102 magnastat iron, which was perceived to offer a good all round performance and replacement parts at modest cost. The desolder bits are easily removed and do not bond themselves to the iron. Three bits, DS 112: DS 113 and DS 114, are all that is required to cope with most desolder operations but there is also a range of surface mount desoldering attachments available. For further info contact

Keith Lawrence
on 0425 274274
Distributed by:
JJ Components
Tel: 081 952 4641

PORTABLE POWER

SAJE Electronics of Cambridge has announced the launch of a portable power supply suitable for many applications including boating, yachting, caravanning and camping, as well as for use by motorists and in DIY.

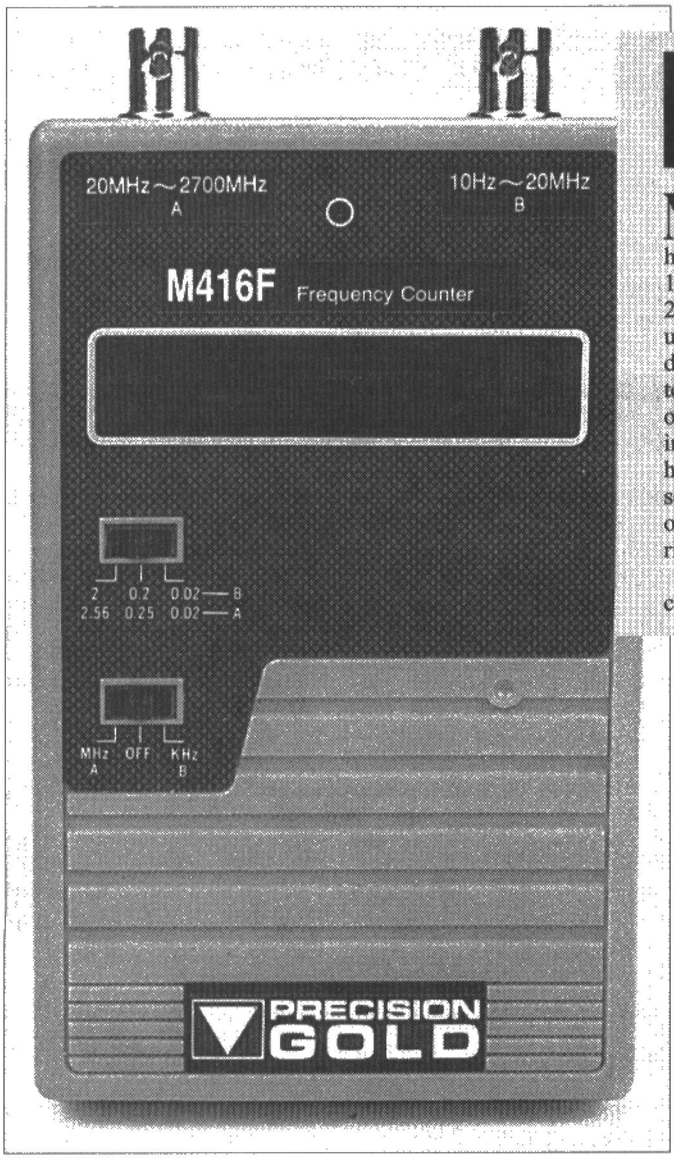
Compact in size for its power, it is designed for multi use. An inbuilt fluorescent light provides up to 5 hours of continuous lighting on a full charge, while a separate flash light is used as a red flashing warning light. It has separate DC outputs at 6 and 12V to supply external electric tools, portable appliances, televisions and toys and also includes jump start cables to assist in starting engines.

Called the Power Tank, the unit can be charged from either a 12V car cigarette lighter socket which takes approximately 4 hours to fully charge whilst driving, or from a 240V mains supply. There is an internal circuit breaker to protect the instrument from overload conditions and a battery level meter is fitted to monitor battery condition.

The Power Tank is supplied complete with cables, a protective carry case and mains adapter, for the price of £76.50 plus VAT.

For further information please contact:-

SAJE Electronics, Tel; (0223) 425440



DIGITAL FREQUENCY COUNTER

New from Maplin Electronics is a pair of compact, hand-held frequency counters, the 1.2GHz Counter M415F and the 2.7GHz Counter M416F. Each unit features an eight digit LED display and is powered from internal batteries. The counters have only two switches and two BNC input sockets. The lower switch has a centre off position and can select either input, while the second switch selects the gate period.

These high sensitivity meters can be powered from an external 12V DC supply (not supplied) which will also recharge the internal batteries. Normal recharge time is 5 hours and the meters can operate for 4 hours with a full charge. Overcharge protection is included.

The meters are intended for use by any hobbyist, radio amateur, engineer or student who needs an accurate and versatile means of frequency measurement. The 1.2GHz Counter sells for £129.95 (to incl. VAT) and the 2.7GHz version £169.95.

BNR OPENS EMC TEST CENTRE

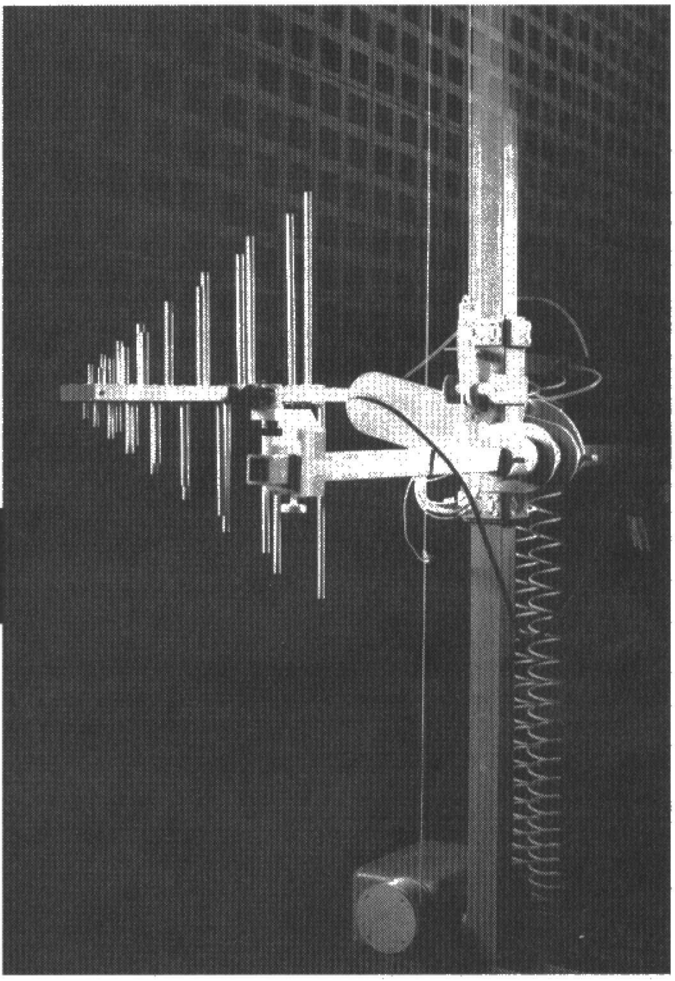
BNR Europe has opened Europe's first Electromagnetic Compatibility (EMC) Test Centre to use ferrite grid absorber tiles. The Centre, built at a cost of over $1 million (£647,000) at the company's Harlow laboratory, incorporates a semi-anechoic chamber lined with more than 23,000 of the novel ceramic tiles.

The centre will enable the company to test and evaluate telecommunications products to ensure full compliance with the EMC Directive 89/336/EEC.

The Directive stipulates strict product regulations for the emission of, and susceptibility to, electromagnetic energy with the aim of curtailing the growing risk of interference between electronic and electrical equipment.

The new Centre is to be promoted as the cornerstone of a comprehensive EMC test and consultancy service to other UK manufacturers and distributors of Information Technology and telecommunications equipment.

The ferrite tile technology has been proven in extensive commissioning trials and provides high quality, consistent results with the bonus of a virtually maintenance free life compared to conventional organic linings. The small 19mm depth of each tile has also enabled the company to build an anechoic chamber one quarter the volume of that needed if traditional materials had been used.



The tiles absorb incident electromagnetic energy over the frequency range 30MHz to 1GHz and provide a return loss of approximately 18dB at 30MHz, increasing to 40dB at 200MHz and decreasing thereafter to 17dB at 1GHz.

To achieve a negligible reflection, the characteristic impedance of the tiles matches that of free space, as close as practically possible across the frequency range of interest. The metal plate upon which the tiles are mounted helps to ensure this match by modifying the input impedance, a function of the tile's permeability, permitivity, shape and dimensions, to provide a good match at the ferrite/air interface.

The tiles can best be looked upon as a ferrite dielectric transmission line with a short circuit load provided by the plate.

PIN HIGH PHOTODIODE

Telecom Devices has introduced a new Planar PIN Photodiode with a photosensitive area 10mm in diameter.

Designed to work at Telecommunications and Datacommunications wavelengths of 1300-1550nm, the actual Spectral range is 850-1650nm. The device is now available in the TO3 style package, although other package styles can be supplied.

Characteristics of the 35PD10M include, responsivity of 0.85 A/W at 1300nm, low Dark Current of 20µA, Rise Time of 1µs into 50R, and a Dynamic Impedance of 200k.

Although initially available with a circular photosensitive region, other geometric designs will be available later, consistent with alternative packaging options.

Applications for this large area PIN Photodiode will include high sensitivity Test and Measuring Equipment in the 1000-1550nm field, as well as Receiver and Sensor work with Telecommunications and Datacommunications.

For further details contact:
Access Pacific Ltd
Tel: 0234 376695

REDUCTION IN PIRACY PROBLEM

Statistics revealed recently have shown that the level of software piracy has declined in most European markets, although the problem continues to inflict heavy losses, estimated at US$4.6 billion in 1992, upon the European software publishing and distribution industries. After a continual rise, the piracy fell in Europe from approximatly 77% in 1991 to a level of 66% in 1992.

"We have finally seen the tide turn against software piracy in Europe, but we have a long way to go before we can declare victory," said Brad Smith, BSA European Legal Counsel. "The Business Software Alliance's goal is to decrease the supply and demand of pirated software and expand the size of the legitimate software market, and we are steadily advancing toward this goal. However, we will not stop until pirated software is reduced to a zero market share in Europe, and around the world."

According to the BSA's estimates, the reduction in software piracy in 1992 added approximate US$700 million in revenue to the European software publishing and distribution industries.

"The reduction in software piracy created more than 8,000 new jobs in the European software industry last year, including new positions in publishing, distribution, and training companies," said Smith.

The reduction in software piracy is attributed to several factors, including the completion of the European Community Software Directive, which has strengthened copyright laws throughout the member states; creative marketing campaigns conducted by local software associations in individual countries that have increased awareness for the benefits of original software; and an increased pace of legal actions to enforce copyright laws against infringers.

"Last year, the BSA filed more than 100 legal actions in 10 countries in Europe, and coupled with strong informational campaigns about recommended sofiware management practices, we believe the market is finally getting the message that it does not pay to engage in illegal copying," said Smith.

In 1992, software publishers and resellers incurred the highest losses in France, US$1.257 billion, and faced the greatest degree of pirated software in Italy and Spain, where illegal software held 86% of the market in both countries.

THE PC VIDEOPHONE PREVIEWED

BT and IBM UK have previewed the PC videophone. It is thought the low cost face-to-face communications product could transform the way business operates in the future.

The PC Videophone combines telephone and computer to give users the chance to see and share information with the person they are talking to without leaving their desk. In a joint venture, IBM has produced the software with BT technology providing the latest dimension in communications.

Nick Temple, Chief Executive IBM UK, said that the new product would revolutionise business life. "It's the most exciting development in this area of communications for some time and there is massive potential for it to become an office standard."

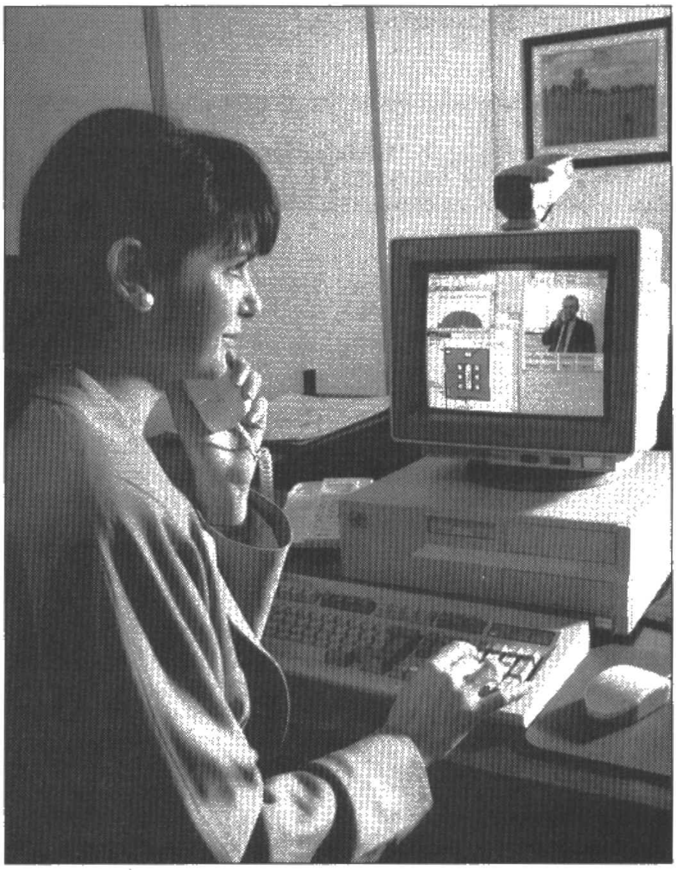
The PC Videophone conforms to the CCITT international standard H.320, which not only allows the product to interwork with videoconferencing systems and videophones but also protects the business investment when purchasing the PC Videophone.

"The main benefits to users will not only be faster decision making, speedier and more efficient use of scarce human skills, cost and time savings from reduced travel, but also the added applications including: access to remote expertise; project management support and staff training," said Chris Frost, IBM UK's PC Videophone Project Manager.

The software uses a graphical interface to provide a video picture in one window, enabling users to work simultaneously in other windows sharing the data they wish to discuss.

As the voice, video, and data operates using BT's ISDN service, the user can also take advantage of the competitive ISDN call charge both in the UK and overseas. At present 90 per cent of UK businesses have access to the ISDN service via over 4,000 modern telephone exchanges.

The PC Videophone kit, comprising software, multimedia communications card, solid state camera and a telephone handset, will be available by the fourth quarter of this year, at a price of approximately £3,000 - £3,500.



ETI NEWS ...Stateside...

Start All Over Again

Both Motorola Inc.'s Cambridge Research Centre and the Computation Structures Group at Massachusetts Institute of Technology are relying on a special custom version of the 88110 RISC processor for the new Start project. This is the successor to the Monsoon parallel data flow computer project.

In presentations at the recent IEEE CompCon conference in San Francisco, Motorola revealed that the processor used for the system, the 88110MP, adds more hardware and new instructions to the basic instruction set in order to handle the special message-passing needs of the Start architecture.

Originally, developers hoped that Start would be scaleable to 1,000 processors, but by putting the 88110MP on special multichip modules and assembling the MCMs in special 3-D bricks, the 512-processor system currently in design can be scaled up to 4,096 processors. The 88110MP was optimised for Start and Motorola does not plan to commercialise the processor.

The Start architecture allows for greater use of parallel processing when the computer is engaged in long-latency memory transactions, through the use of special split-phase transactions. These transactions require such a high level of interprocessor message-passing that the original 88110 had to be augmented with new register sets and a special message and synchronisation unit (MSU).

The addition of the MSU required the expansion of the 88110 instruction set to cover 25 new instructions specifically for the MSU. Some of these are used for message-passing, while others carry out a form of multi-threaded compilation that Motorola calls 'micro-threading.' The creation of micro-threads for handling processes between CPUs allows the Start system to carry out its split-phase transactions.

The 88110MP processors are linked in a topology known as a 'fat tree,' used in such architectures such as Thinking Machines Corp.'s CM-5. In a fat tree, the CPUs are seen as 'leaves' of the tree network and each move up the branch represents a move up in the networking hierarchy. Four of the 88110s are connected locally through one router chip, four clusters of four (or 16 CPUs) are controlled through the next layer, etc..

While the operating system uses many Unix-like commands, the lack of a central clock means that the model of parallelising tasks is special. The manager process assigns several child processes called 'players,' with players distributed one per processor for all processors assigned to a parallel task.

The manager process cannot have direct access to the MSU block in the 88110MP, in order to communicate with players; instead, it uses standard Unix inter process communication methods.

Currently, Motorola is scheduled to deliver 32-processor and 512-processor versions of the Start system to MIT in 1994. The first will be a departmental supercomputer platform with performance in the 3-Gflops region, while the 512-processor system will aim for performance of roughly 50 Gflops.

Terminator, Too

A new type of terminal block has been designed for PCBs. It uses a patented contact and actuation design to make connections to a wide range of wire sizes. A turn of a small actuator bar enables a wire to be removed and a new wire inserted and connected.

In making a termination, an operator places a wire against the stop in the applicator opening and depresses the built-in lever. This forces the wire against the 'zero gap' metal body, displacing the wire insulation for an electrical contact. When used with stranded wire, there is no damage to individual strands and opening the lever moves the wire from the terminal contact.

Produced by Pheonix Contact, Harrisburg, Pennsylvania.

Electric Vehicles On The Move

To support the development of fast-charging hardware that is expected to improve the effective range of electric vehicles, the US Federal Transit Administration has awarded the Advanced Lead-Acid Battery Consortium $1.2 million in matching funds.

The ALABC fast-charging research programme aims to develop battery-charging hardware that can return roughly 50% of a full charge in 5 minutes, 80% in 15 minutes and full charge in 4 hours. Contemporary electric vehicles have a range of roughly 80 miles, depending on conditions, with a fully charged set of lead-acid batteries.

Traditionally, the prospect of recharging EVs has been considered an overnight proposition, dovetailing with the extra capacity of electric utilities during off-peak hours.

"Opportunity charging allows the consumer to benefit from the cost advantage of lead-acid batteries and still enjoy reasonable range from an electric vehicle," said Robert F. Nelson, ILZRO's manager of chemistry and electrochemistry. "Though other battery designs may offer greater range in theory, material costs alone can be as much as 10 times higher than lead-acid," he pointed out.

In another move, the US Council for Automotive Research (USCAR) has announced that its members, Chrysler, Ford and General Motors, have signed an agreement to investigate cooperation in the design, development, testing, and possible manufacturing of electric vehicle components. The group will explore opportunities for common designs and specifications of electric vehicle systems and subsystems that would ultimately be used in each company's own vehicle.

USCAR, an umbrella organisation formed to recommend, monitor and develop cooperative non-competitive research among the Big Three, now has nine consortia under way. The new electric vehicle group is being established to find the most effective way to hasten electric vehicle development, in order to help meet the US national and industry goal of providing clean, efficient, domestically fuelled, personal transportation.

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Ⓧ NOTE- ADDED TO ETI DECEMBER 1992 P.16
Ⓨ " " " " JUNE 1993 P.12

READ/WRITE ETI Letters

Mains Inverter Comments

Ⓧ

With regard to the mains inverter in the December issue, the use of two 4mm connectors was suggested for high current low voltage. Although not the cheapest, the use of three pin XLR plug and chassis socket made a much neater job.

I built the unit so I could demonstrate small portable TVs at car boot sales. Battery leads are expensive and difficult to obtain. It does this job satisfactorally, but will not do larger colour TVs-typically 150watts. I have noticed that when I tried it with two mains radios one valve and one transistor, an intolorable buzzing occurs. The valves light up OK but the AC only set had to have the earth lead connected to lose it. What is happening here? Are there modifications that can be done to the inverter to overcome this effect?

You said in connection with the mains tester checker that 90V HT batteries for portable valve radios were expensive. Apart from a source called The Vintage Wireless Co.,I didn't know that they were obtainable at all!

I had heard of a unit which generates the rail from a PP3 battery but costs £50. May be your checker project could be adapted for this.

Mark Daniels replies:

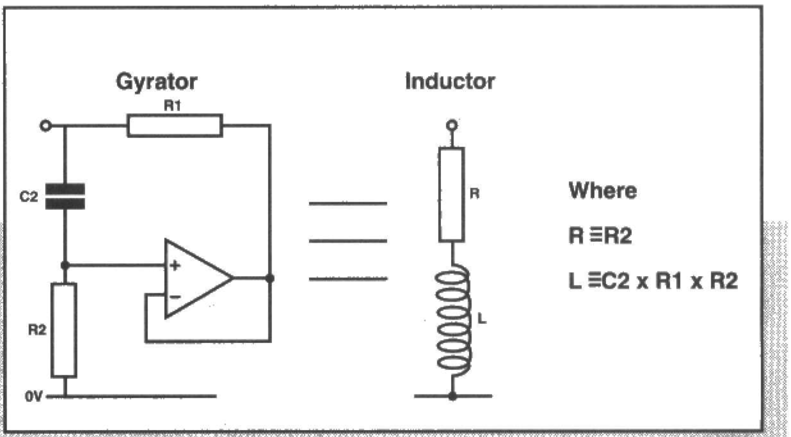
I will take the points in the order in which they are raised in your letter.

The connectors suggested for the 120 Watt version of this inverter were recommended as cheap and readily available. I agree with your suggestion that the use of XLR connectors in this application is probably a better alternative. However, I would suggest the use of the 'reversed' version of this connector (ie. panel mounted plug, lead mounted socket) in Maplin's low cost range, plug KC54J, socket KC57M.

I find it rather surprising that a 120 Watt inverter will not run larger colour televisions, I have run 26" models from this size inverter on several occasions. It may be that the televisions in question are older models with a 'dropper' type supply requiring more power than a modern set using a mains transformer or switched mode supply.

A 225 Watt version of this design is available as a component kit (excluding PCB) from JPG Electronics, Chatsworth Road, Chesterfield, Tel: 0246 211202. The transformer and suitable power transistors (type MJ11016) are also available separately from this source. A 225 Watt toroidal transformer has been produced specifically for use in this design and will perform better than a standard mains transformer used in 'reverse' as suggested in the article.

Low frequency interference (buzzing) has always been a problem with radios of the type mentioned and to a lesser extent with televisions. It is usually possible to cure it by effective earthing as you mention in your letter. A copper grounding rod driven 1.5 to 2 metres into damp ground and connected to the earthed side (neutral) of the transformer secondary may be helpful in more obstinate cases. Where mains electricity is installed the earth connection may conveniently be made to the normal mains earth Ü



5-Band Graphic EQ Maths

Ⓨ

Regarding the 5-Band Equalizer featured in June 93 ETI, I am interested in using this circuit as the basis for a 3-Band sweepable EQ, which are quite expensive commercially. Could you print the mathematical formulae for determining centre frequency and the Q of the gyrator circuit, as I cannot find this in any published texts.

Constructors may like to include a small (39p) capacitor across R7 in the circuit, to ensure stability of IC2. For a future project, how about a complete +/-15V regulator using the LM317/337 regulators and 15VA toriodal on one PCB.

F Stewart, London.

Andrew Armstrong replies:

If you wish to sweep the frequency of the stages in the graphic equaliser, you can do so to a limited extent by varying R1. However, the practical range is not very great because R1 must remain considerably greater than R2, and in any case varying it will affect the Q to some extent.

The gyrator circuit used in the 5-band graphic equaliser project replaces an inductor. The inductance can be calculated by writing the equation describing the behaviour of the circuit, and equating this to the standard equation describing an inductor and a series resistor. This permits calculation of the equivalent inductance in terms of the resistors and capacitors in the circuit.

The article did originally include the formulae and a brief outline of their derivation, showing the approximate equivalence between the action of the gyrator and an inductor, but they were judged unlikely to interest constructors.

The answer comparing the gyrator with an inductor and a series resistor, is shown in the diagram.

The centre frequency of the circuit is then calculated using the standard formula:

$$f = \frac{1}{2\pi\infty LC}$$

where C is the external capacitor

and Q is calculated using:

$$Q = \frac{2\pi fL}{R} = \frac{2\pi L}{R} \infty \frac{1}{2\pi\,\overline{LC}} = \frac{\overline{L}}{R\,\overline{C}}$$

This allows calculation of Q and centre frequency of the active tuned circuit. Such a circuit has the advantages that it can use inductance values which are not obtainable as standard components, and that it does not add the inevitable slight distorion caused by magnetic non-linearity. However, sometimes inductors themselves are better choice for a particular application eg for low power consumption.

SEE ETI
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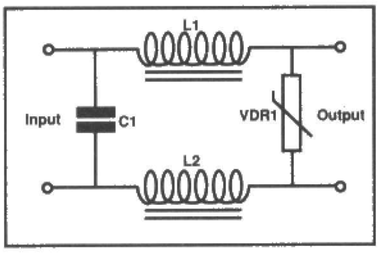
via the earth pin of a three pin plug.

A squarewave consists of a fundamental sinewave and all the odd harmonics in the appropriate ratios theoretically up to infinity. A sinewave, by comparison, consists only of the fundamental wave and is normally the only source of a.c. which needs to be filtered out by mains equipment, which will normally have been designed to do just this. The output of the inverter is, of course, a squarewave which will introduce frequencies into the equipment which may not be effectively removed by any filters built into the appliance, so additional filtering of the supply will become necessary.

A low pass filter connected between the output of the inverter and the affected appliance will remove some of the harmonics from the square wave output of the inverter, producing a more ideal waveform for sensitive appliances. Maplin list a ready built unit which may be suitable, catalogue no. KR96E.

For those who wish to build their own I present a simple filter circuit in the figure below which I have used successfully on many occasions. The design may appear 'back to front', but it should be realised that the transformer secondary will provide the necessary inductance for the first stage of this filter. Suitable values for the components are 4 to 10H, 1A rating for L1 and L2, 100n to 470n 250V AC, for C1 - this component MUST be a class X mains rated device, VDR1 is a 275 volt metal oxide varistor, 275LA15 or similar. A certain amount of experimentation may be necessary to obtain best results.



I must admit that I cannot recall having seen 90V HT batteries on sale in the shops for a number of years now. Wilkinson's definitely used to stock them some time back, but I am not sure whether they still do.

Suggested projects

A modular form of the following FX: Digital Echo and reverb, vibrato, phasing, flanging,chorus and ADT.

Next an instrument that has a few titles. It is known as a harmony generator, a pitch shifter or a pitch transpozer.

Wayne Human
Southdale
South Africa

Wayback in the heyday of analogue electronic music synthesis, vibrato, echo phasing and chorus to name but a few, ETI published circuits galore. Digital circuits have not been so frequent, owing to their complexity and I agree its high time we saw renewed amatuer interest in creating these in the digital age instead of leaving it to the Japanese. ***Ed***

I have not come across the portable h.t. unit which you mention, but I assume it is similar to the unit which replaces the difficult to obtain 15 volt battery in Avo 8 multimeters. This unit is listed by RS Components, catalogue no. 611-048 and has a similar price tag.

I am uncertain how much HT current valve radios require, but the Proving Unit can only output a very small current (a few milliamps at most). This may well be sufficient, but you will need to experiment and see. You may also find that this circuit will cause more interference than the battery to mains inverter, due its much higher switching frequency.

The number of turns on the secondary of the HF transformer in the Proving Unit will need reducing. A simple half-wave rectifier, smoothing capacitor and possibly zener regulator will have to be added to the secondary to produce DC for the valves.

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BLUEPRINT

The Blueprint column is intended to suggest answers to readers' electronics design problems. Designs are only caried out for items to be published, and will not be prototyped by the columnist. Circuits published in Blueprint are believed to work, but may need minor alteration by the reader after prototype. Individual correspondence will not be entered into, save as necessary to prepare items for publication.

Kilyobas N. Binga of Hold Trade Air Services Ltd. sent a fax to the ETI offices, to ask about a triac drive circuit. His fax shows the section of circuit illustrated in Figure 1.

He found that, when power was switched on, although switching signals were reaching the MOC3020, the 12W lamp remained on all the time. He then tried disconnecting the gate connection to the triac, which caused the lamp to flash and eventually, after 15 minutes, to remain on.

The project is to build a large clock display, which can be read for 100 metres away. He requested procedures for calculating component values to be used with the MOC3020 and the TIC226M, so that he could make the unit work. Would I be right in guessing that the project is required for use in an airport, perhaps?

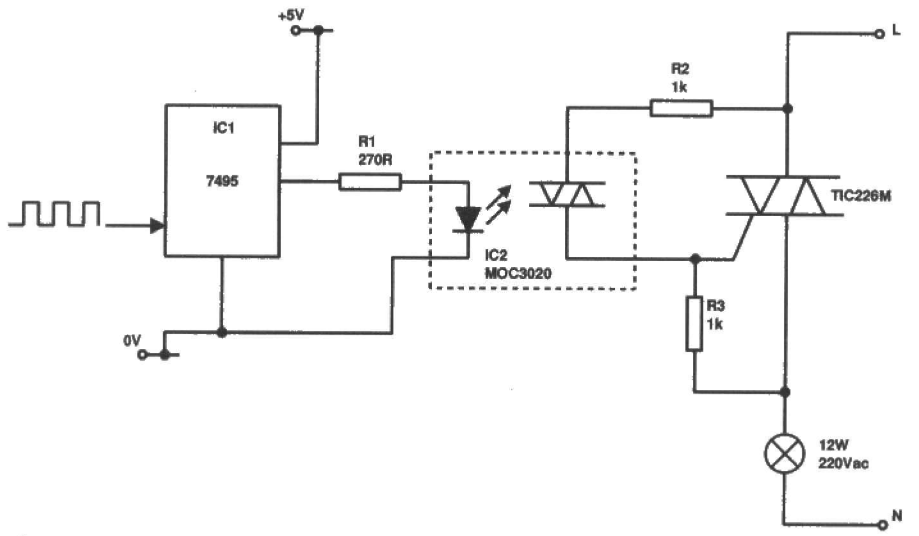

Fig. 1

Cause and Effect

First of all, why does the lamp remain on when the MOC3020 is apparently being switched by its logic drive? There are four obvious possibilities and it should be quick to find out which is the culprit. The MOC3020 may be receiving drive when it appears not to be, the MOC3020 may be defective, the triac may be defective, or the mains supply may contain such a high amplitude of spike interference that the triac is being broken down (which causes false triggering).

To find out which is the cause, first disconnect R2, not the gate connection to the triac. This leaves R3 connected as a bleed resistor for any leakage current or noise which may reach the gate. If the lamp remains off when R2 is disconnected, than reconnect R2 and disconnect R1. If the lamp now remains off, then the drive is at fault, while if it remains, on the MOC3020 is defective.

If the lamp remained on, then either the triac is defective, or it is being falsely triggered by mains spikes. It is, in any case, a good idea to provide the triac with protection against mains spikes, so a snubber network should be connected as shown in Figure 2. If this cures the problem, then it should not recur, but if it doesn't, the only remaining likely cause of the problem is that the triac is defective, so it should be replaced.

A Question of Choice

Several points need to be made about the choice of components and values. First of all, the MOC3020 is rated as requiring 30mA of LED current to guarantee triggering. Most units I have tested will trigger quite satisfactorily with less than 10 mA, but in a large installation the official ratings of devices should be borne in mind. The section of circuit diagram shows the opto- isolator driven from a logic gate, which cannot be expected to provide 30mA drive current, particularly not to several loads at once. It might be better to use the MOC3022, which is rated at 10mA guaranteed trigger current.

The TIC226M triac is an 8amp device which requires 50mA of gate trigger current in quadrants 1,2 and 3 and is not rated to trigger at all in quadrant 4 (with gate positive during negative mains half-cycles). The use of an opto-triac to trigger the device, means that triggering occurs in quadrants 1 and 3, so reliable triggering can be expected if 50mA of gate drive is supplied. Clearly, the value of R2 is too high to permit reliable triggering near to the mains zero crossing. A 1W, 470n resistor would be more appropriate.

The triac itself is too large to be suitable for the job of

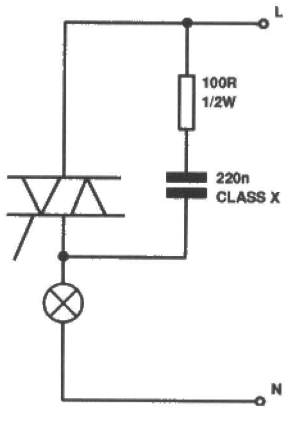

Fig. 2

driving a 12W lamp. When a triac or thyristor is triggered, it continues to conduct until the current falls below a level known as the holding current, a level which maintains sufficient charge-carriers in the junction for conduction to continue. It is unlikely that the current drawn by a 12W lamp will reach the holding current, though this is not specified in my abridged data. The RMS current drawn by a 12W lamp running on 240V AC is only 50mA, while the rated RMS forward current of the MOC3022 is 100mA. It would appear that a single 12W lamp could be driven directly by the MOC3022, the only difficulty being that when a cold lamp is switched on, there is a current surge of several times the RMS operating current and this may cause failure of the MOC3022. Either a NTC thermistor should be connected in series with the lamp, or a lower-current triac such as the TICP206M should be used. This is a 1.5A triac, rated at 8mA trigger current in quadrants 1 and 3. The holding current of thyristors and triacs is usually of a similar order to the trigger current, so the TICP206M should be able to remain triggered over most of the mains cycle.

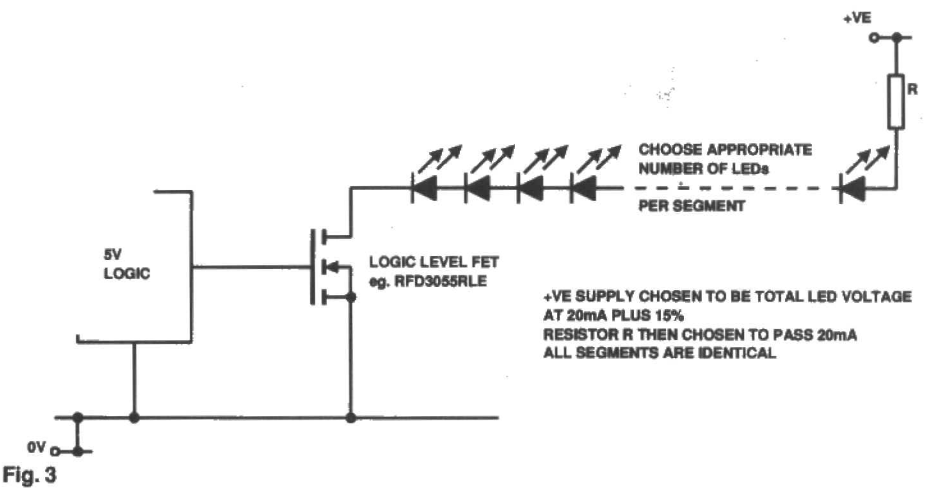
+VE
R
CHOOSE APPROPRIATE NUMBER OF LEDs
PER SEGMENT
5V LOGIC
LOGIC LEVEL FET eg. RFD3055RLE
+VE SUPPLY CHOSEN TO BE TOTAL LED VOLTAGE AT 20mA PLUS 15%
RESISTOR R THEN CHOSEN TO PASS 20mA
ALL SEGMENTS ARE IDENTICAL
0V

Fig. 3

Dissipation

Mr. Binga goes on to ask how reliable the clock is likely to be when he calculates that the total dissipation of all the lamps he intends to use is 2.5kW and that the unit will be enclosed in a transparent plastic housing which will limit cooling. My estimate is that reliability would be poor and that there could even be a fire-risk. I would, instead, experiment with the visibility of large, high-powered LEDs operated as shown in Figure 3. If a wide viewing-angle is required, then one of the LEDs from the Farnell catalogue is specified at 550 millicandelas over 100° solid angle. If, on the other hand, a narrow viewing angle is acceptable, another LED from the same manufacturer offers 3 candelas over a 20° solid angle. Clearly, one would need more LEDs than incandescent lamps to give adequate readability at a long distance, but the reliability will be much higher.

A. Armstrong

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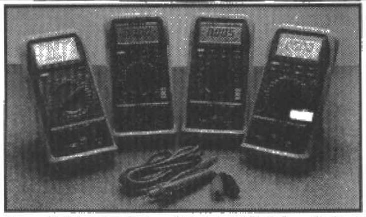

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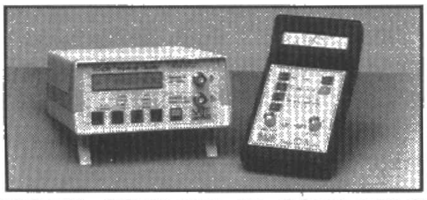

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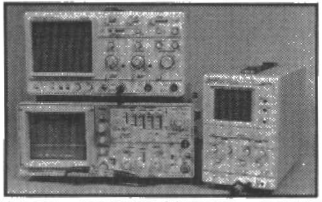

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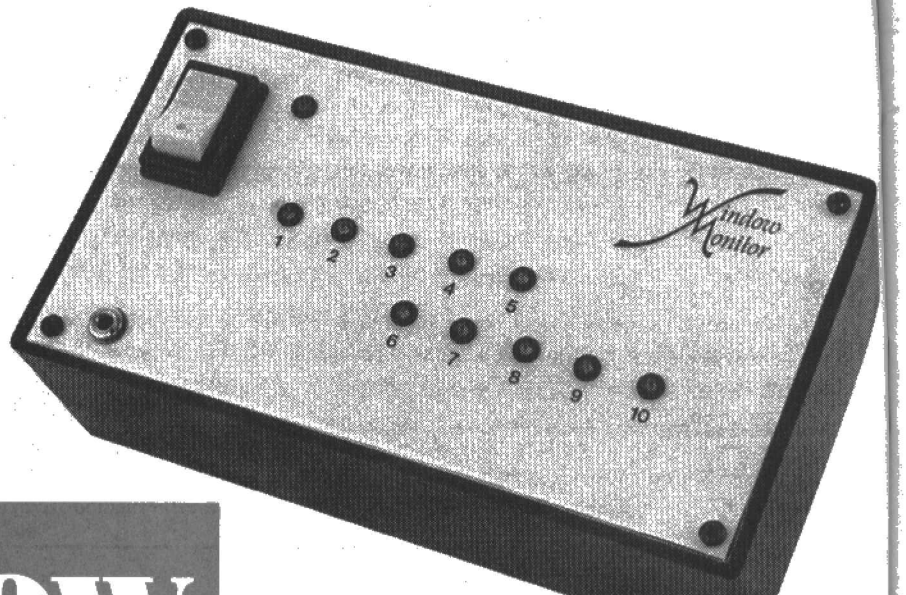

A single loop design to detect remote open windows, by Nigel Smith.

Window Monitor

The window monitor has, as its name suggests, been designed to detect which of one's windows are open or closed. This would be a trivial task if one were allowed separate wires from each window to the monitor, but this was ruled out in the original design brief. The requirement was to monitor greenhouse windows, where there were many windows situated some distance away from the monitor. Separate wires were therefore deemed to be impractical and a system was sought in which the windows are connected by a single cable, in loop or chain fashion. The project was designed to solve this problem, but it may find more widespread use as part of a security system. An alarm trigger option has therefore been included.

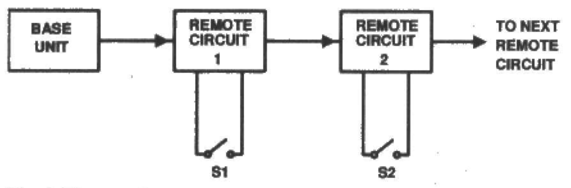

Fig.1 The system

The system consists of a base unit, which contains the power supply and main circuit and a remote circuit, together with a reed switch at each window, as shown in Figure 1. A prime objective has been to keep the remote circuits as simple as possible, so that a large number can be built at a reasonable cost.

Despite its name, the circuit can, of course, also monitor doors or indeed anything else that can operate a switch. Transistors, including phototransistors, may be used instead of reed switches, so the project would make a versatile 'smart loop' if used with an alarm system, since it will detect which switches have been operated.

Operating Principles

The following provides an outline of the system operation - see 'How it works' for further details.

The base unit supplies a pulse train to the chain of remote circuits, each of which routes the first pulse it receives to its switch. All subsequent pulses are then sent along the chain to the next remote circuit. The first pulse is thus applied to the first switch, the second pulse to the second switch and so on. The relevant waveforms are shown in Figure 2.

The state of the switches is read by monitoring the current in the supply line to the chain. The remote circuits use CMOS ICs which draw a negligible quiescent current but can supply up to 2mA when working at 10V. When a pulse is applied to an open switch, the current remains negligible, but nearly 2mA will be drawn if the switch is closed. The current monitor has simply to distinguish between these two states to tell whether a switch is open or closed.

The output of the current monitor is fed to a serial in/parallel out shift register which stores the data and drives the LED display. An HC series shift register and low current LEDs are used, as the former can directly drive the latter.

I have assumed that the state of the switches will mirror that of the windows, i.e. that the switches are closed when the windows are closed and that a warning light should show that a window is open. For each window there is therefore a red LED, which will light if its switch is open.

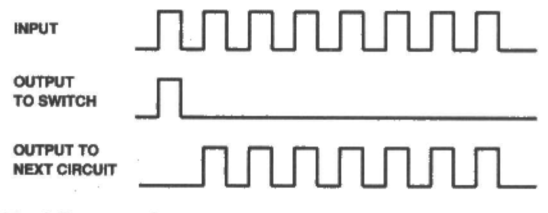

Fig.2 Remote circuit waveforms

The last remote circuit of the chain is terminated by a resistor, which acts as a permanently closed dummy switch. The corresponding LED is a green one which lights to indicate the closed condition. This is used to show that the monitor is operating when all the windows are closed and the red LEDs are therefore off, as well as to provide a continuity check for the chain.

The reading sequence is repeated every 700ms or so, to give a continually updated reading. The duration of the pulse train will obviously depend upon the number of windows connected, but will typically be about 10 to 20ms. During this time, the LEDs will flicker as the data moves through the shift register, so the display will show a slight flickering at about 1.5Hz in use.

Power Supplies

A choice of mains or battery power supply circuits has been provided. These are shown in Figures. 3 and 4 respectively. Both give nominal 5V, 10V and 15V lines, although the recommended battery voltage is actually 6V. Four 1.5V cells or five 1.2V rechargeable cells should be used. Alternatively, a stabilised 5V or 6V supply may be used with the battery version.

Switching Options

Although the window monitor was designed to operate using reed switches, active sensors and auxiliary circuits may be connected by using transistors as switches. Connect the emitter and collector of an NPN type to points S1 and S2 respectively, vice versa for a PNP type. The connection points are shown in the remote circuit component layout, Figure 12.

A point to watch here is earthing. Connection via transistors is suitable only if the circuits driving them are floating, i.e. if they have no connection to earth nor, worse still, to live, neutral or half live mains. If the window monitor itself is not earthed, then one earthed auxiliary circuit is permissible, but if in any doubt, use an opto-coupler. Most types are suitable and the method of connection for these and for phototransistors is as described above for transistors. The requisite ratings for the above devices are modest. The 'on' current is only 2mA, the 'off' voltage is 10V and leakage current up to 100µA is acceptable.

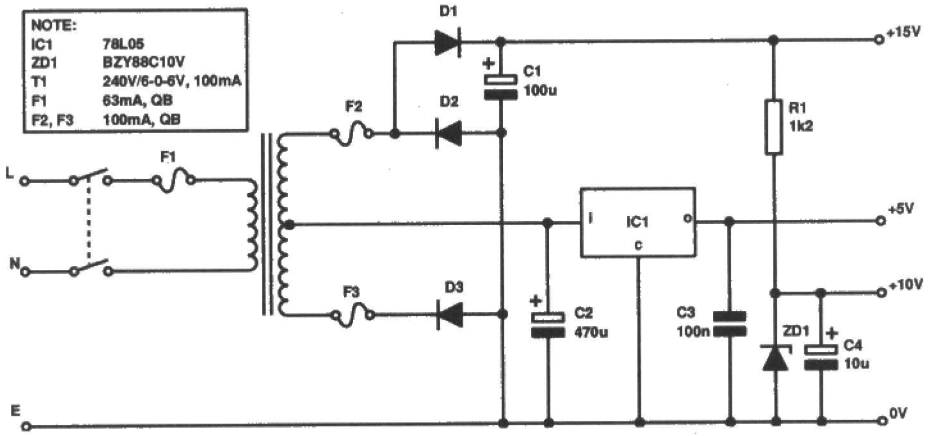

Fig.3 Mains power supply

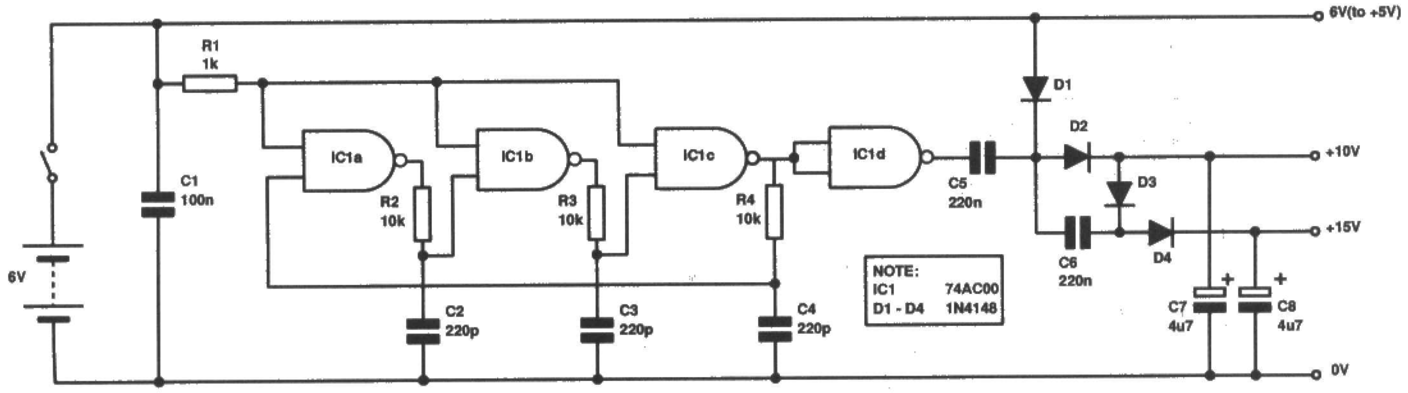

Fig.4 Battery powered supply

A voltage tripler was chosen for the battery power supply, because the higher voltage lines require much less current than does the 5V line. It would have been possible to run the remote circuits at 5V, but some voltage overhead would still have been required for the current monitor. While a voltage doubler could have provided this, the addition of a couple more capacitors and diodes creates a tripler which enables us to run the remote circuits at 10V. This is advantageous, because of the higher output current capability of CMOS chips at the higher voltage. The detector of the current monitor can therefore be less sensitive than otherwise, so that noise immunity is improved.

As stated above, it has been assumed that the LEDs are required to be on when the switches are open. If, instead, you want a LED to be on when its switch is closed, then connect it to the 5V line as shown in Figure 6 for LED 6, the green LED, instead of the 0V line as shown for the others. The relationship between a switch and the corresponding shift register output is that an open switch gives high output, a closed switch gives low output. This applies for all types of

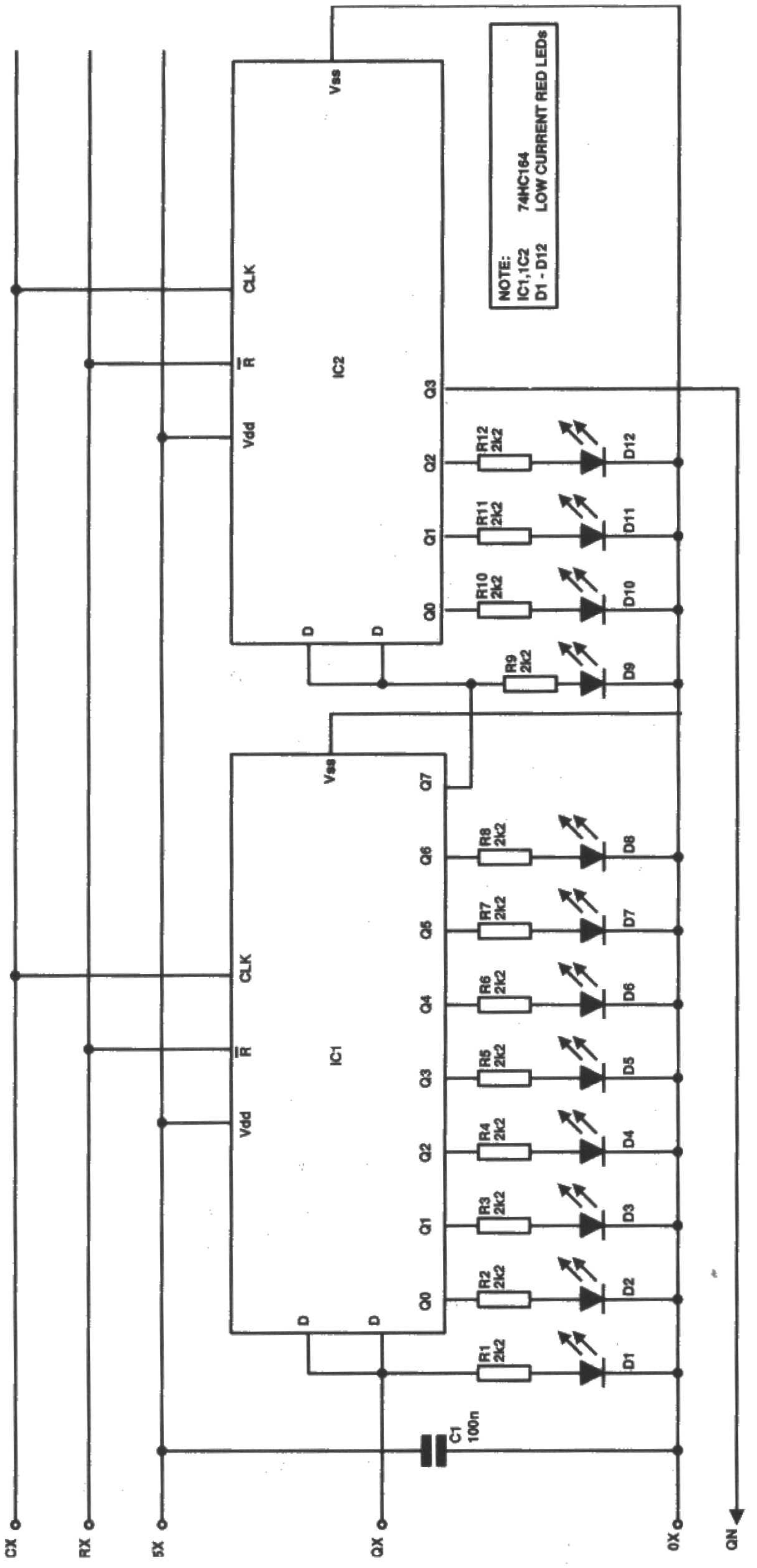

Fig.5 Expansion circuit

switches and both methods of LED connection.

Windows can be 'ORed' by wiring their switches in series with one remote circuit. This arrangement could be useful if you have two or more windows close to each other and it is not necessary to know precisely which one of them is open.

HOW IT WORKS

Power Supplies

The mains PSU, shown in Figure 3, requires little explanation. Full wave rectification and a regulator IC are used for the 5V line, while unregulated half wave rectification is sufficient for the other lines.

The battery PSU, shown in Figure 4, uses ICs 1a, 1b and 1c to generate a 150kHz square wave. This drives the voltage tripler via IC1d to produce the 10V and 15V lines.

Main Circuit

The main circuit is shown in block diagram form in Figure 13 and in the circuit diagrams Figures6 and 8. The diagrams and the text below refer to the case where there are five remote circuits. For the general case where there are n remote circuits, read Q(n+1) for Q6.

The reading sequence is initiated by a pulse from the system reset circuit, which comprises IC1d and associated components. The pulses are negative going, approximately 2ms wide and repeat at 1.5Hz.

The clock generator consists of IC1a and its associated components. It oscillates at about 750Hz, unless it is disabled by a high on output Q6 of the shift register. The clock is therefore enabled by the reset pulses, which take all of the shift register outputs low.

The signal and 10V outputs to the remote circuits are controlled by the latch ICs 2b and 2c. The 10V output cannot be left permanently on because the remote circuits need to be reset for each reading sequence, but this is achieved automatically by switching on the 10V output. When this the data input of the shift register, will be high. This logic 1 becomes a marker bit which controls the latch ICs 2b and 2c. At the first clock pulse after the reset, the marker will be shifted to the first register output, Q0. This sets the latch, which now turns on the signal and 10V outputs. Subsequent clock pulses are output to the chain, while the marker is moved along the register with the switch state data from the current monitor following behind it. When it reaches Q6, the marker stops the clock and resets the latch, so the outputs to the remote circuits are turned off and the data remains in the register until the next reset pulse.

ICs 1b and 3a are used for logic level shifting at the latch inputs and they also form gates, as shown in the block diagram, Figure 13. IC1b allows the latch to be reset by the system reset. This is only necessary for the initialisation of the latch, which will subsequently always be reset by the marker at Q6. IC3a prevents the latch from being set when Q6 is high. This ensures that an open circuit chain condition (putting Q0 high and the green LED off) does not try to set and reset the latch simultaneously.

The operational amplifier IC3b and R19 form the 10V output and current monitor. The voltage of the 10V output line, being also that of the op-amp negative input terminal, will follow the voltage of the positive input terminal. This will be 10V when the latch is set and 0V when it is reset. Any current drawn by the output line will flow from the op-amp output through R19, so the op-amp output voltage will depend upon the said current. When one of the remote circuits applies a pulse to its window switch, the output of the op-amp will be 10V if the switch is open or 12V if it is closed. The network Rs 17 and 18 drop the voltage to approximately 9V or 11V respectively, so that the comparator

Alarm Trigger

If this function is not required, then omit R26, Q1, IC4 and the long link next to it from the main circuit board.

The alarm trigger is output via an open collector transistor. When this is connected to a pull up resistor in the alarm circuit, a positive going pulse will occur if any of the window switches is open. The pulse width is about 1ms and it will repeat every 700ms or so, as long as the switch remains open.

A chassis connection must be made between the window monitor and alarm circuits, so one must be mindful of earthing. If both monitor and alarm circuits are earthed, there is not likely to be a problem, provided that the alarm has its negative or 0V supply line earthed and the two circuits are situated reasonably close together (e.g. in the same room). The best arrangement will depend upon the alarm system in use, but in general the earth connection to the mains powered version of the window monitor should be omitted only if there is a permanent earth connection via an alternative route.

IC1c can compare this to a 10V reference. The comparator output is then fed to the data input of the shift register. The register is clocked at the trailing edge of each output pulse, so the capacitor C2 is used with Rs 17 and 18 to hold the comparator input. The integrating network thus formed will also help to prevent the data being depraved and corrupted by any unpleasantness that may be picked up by the chain.

The alarm trigger circuit takes the shift register output Q0 and passes it to the transistor Q1 via the gate IC4d. All of the switch state data passes though Q0 during the reading sequence, so any open window switch will cause a pulse to trigger the alarm by turning off Q1. The marker bit is excluded from the trigger output by the latch formed from ICs 4b and 4c, which turns the gate off when the system reset pulse occurs. The gate is then turned on by the marker when it appears at Q1, having passed though Q0.

Remote Circuit

The 4555 dual 2 to 4 line decoder is used in a rather unusual application here, so an explanation of its functions is given. The input and output waveforms of the circuit are shown in Figure 2.

Taking IC1b first, inspection of the truth table, Figure 14, will show that it behaves as a NCR gate, since Q0 is the only output used.

Considering next IC1a, we regard the input D0 as a signal and D1 as a control input. The truth table now shows that the signal can be switched by the control, between the outputs Q1 and Q3, with the signal complement appearing at Q0 and Q2 respectively.

When power is first applied to the circuit, C1 being connected to the positive line ensures that Q0b and hence D1a will be low. Q3a will therefore also be low, as will D0a, since it is connected to Q3a of the previous remote circuit. The initial state of IC1a is therefore described by line 1 of the truth table.

At the leading edge of the first input pulse, the state of IC1a becomes that of line 2 of the table, but the delay imposed by the network R1,C1 ensures a brief overlapping of high inputs to IC1b, so its output remains glitch free at logic 0. At the trailing edge of the first input pulse, the delay now ensures an overlap of low inputs to IC1b, so that its output goes high. The circuit is then latched in this condition, with all subsequent pulses appearing at the output Q3a, until the power is turned off and then on again at the beginning of the next reading cycle.

Connecting the monitor earth to the mains earth via a high value resistor might be acceptable in some cases.

Expansion

The main PCB designed for this project can accommodate three eight bit shift registers. Since two bits are required as overhead, up to twenty two windows can be connected.

More shift registers may be added by using an expansion board, as shown in Figure 5. Each additional register will provide for a further eight windows. Points for the connection of an expansion board are provided on the main PCB. These are 0X and 5X for the power, RX the reset, QX the input and

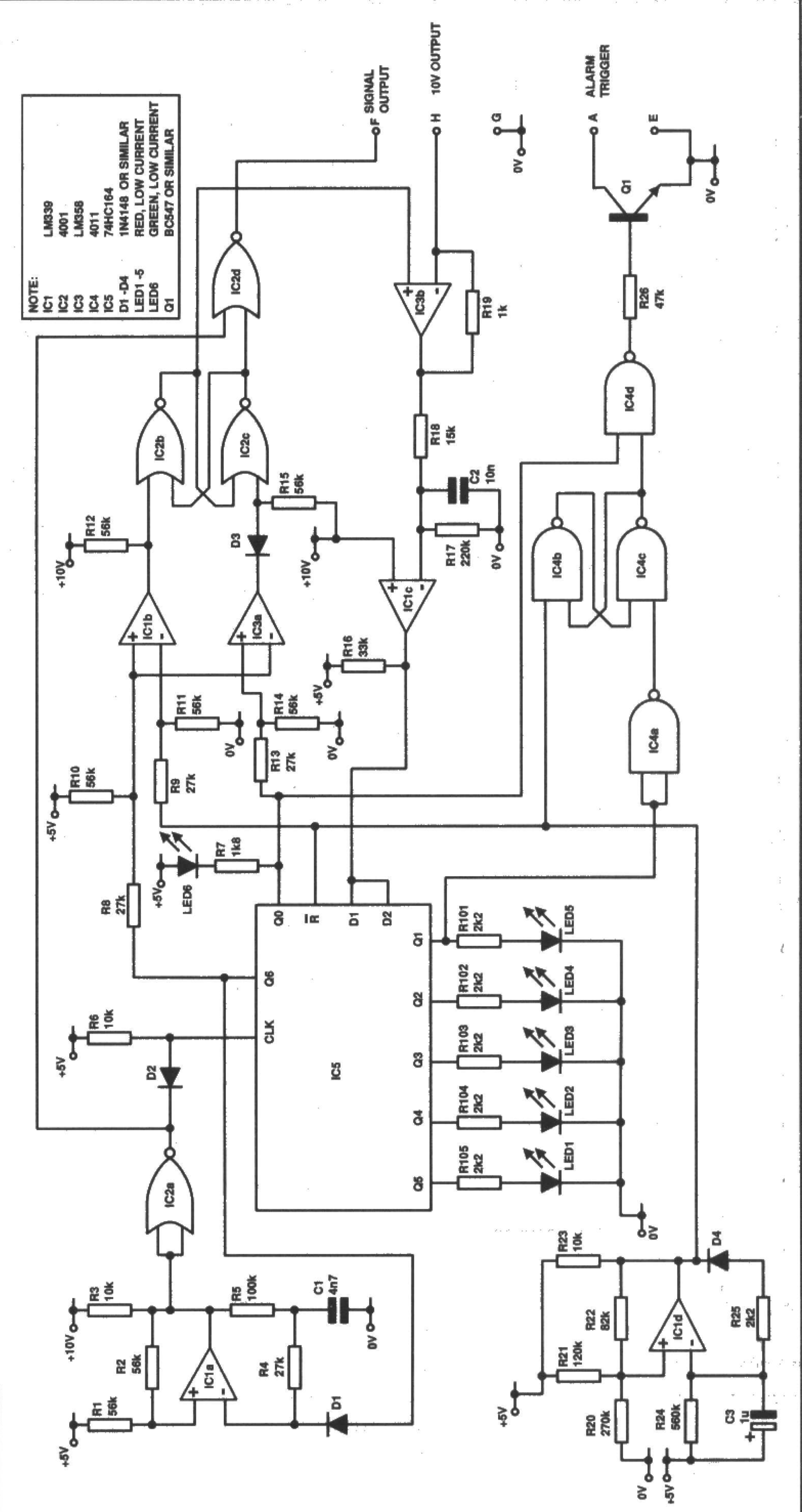

Fig.6 Main circuit

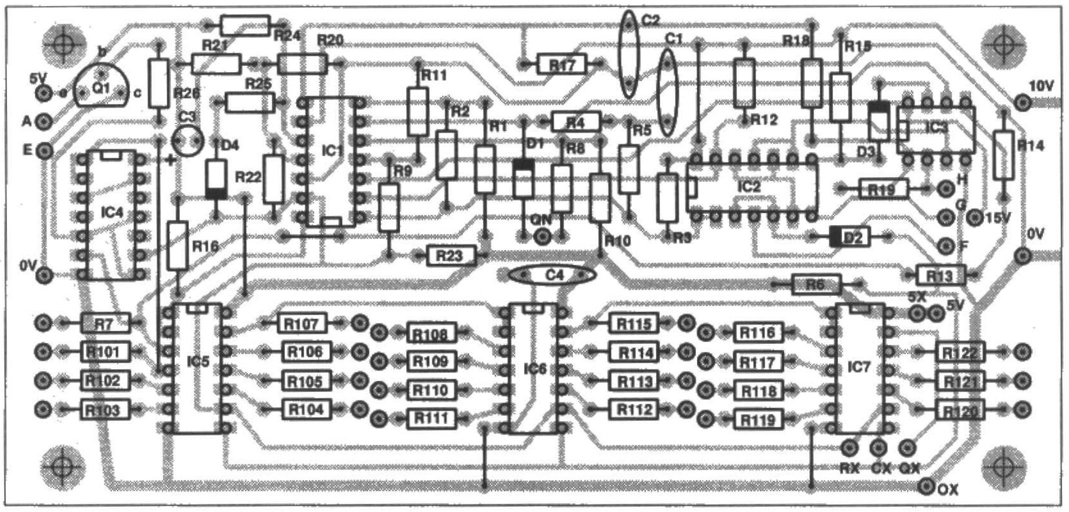

Fig.7 Main circuit component overlay

CX the clock. A return connection to point QN must also be made - see the construction section below about this.

Each LED draws about 2mA when lit and the rest of the circuit about 10mA. The mains driven power supply circuit for the project is rated at 100mA and will therefore limit to about forty the number of windows that can be accommodated. In the unlikely event that you should wish to monitor more than this, a more powerful supply will have to be provided.

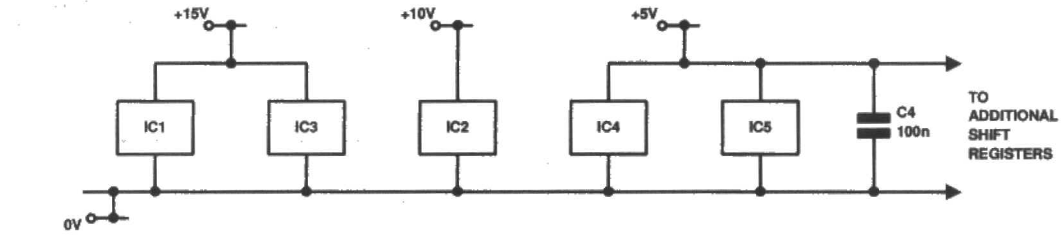

Fig.8 IC Supplies

Another constraint is imposed by the length of the chain of remote circuits, but the limit here is the resistance of the wires rather than the actual length. The combined resistance of the positive and negative leads may be up to 1k, so this is not a severe constraint.

Since the display flickers meaninglessly during the reading sequence, it will not give a clear indication if the ratio of the reading time to the overall cycle time is too large. The period of the output pulses is about 1.1ms and the cycle time about 700ms, so the display will be stable for approximately 90% of the time, if sixty windows are monitored. (Reading time = 60 x 1.1ms = 66ms = 10% of 700ms approx.). This is not a fixed limit but the display will become less intelligible if the number of windows is increased, unless the time constants are altered.

Construction

Separate PCB layouts are shown for the main board and the choice of power supply boards, which together with the remote boards are all made from single sided PCB. Both power supply layouts have, however, been designed such that either of them may be fabricated on the same board as the main circuit if desired. To do this, simply align the 0V and 10V tracks of the main circuit and the chosen power supply layouts, overlapping by one or two mm to form a single layout. The finished board must then have links fitted to connect the 5V and 15V supplies from the PSU to the main circuit.

No casing details are given here, as these will depend upon which power supply is used and the number of LEDs required. The user will also probably want the arrangement

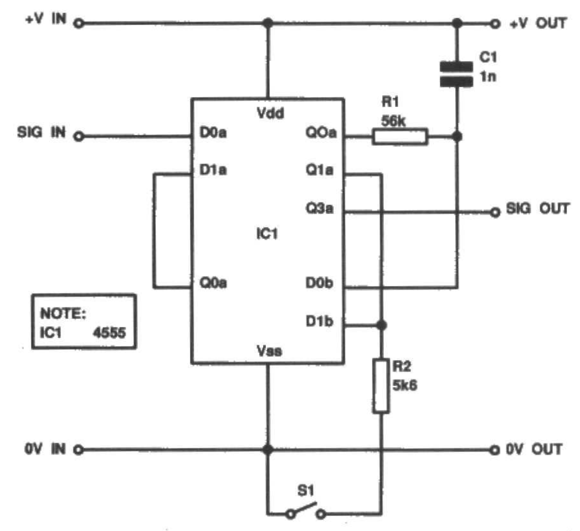

Fig.9 Remote circuit

of LEDs on the front panel to reflect the physical placement of the windows being monitored. No LED PCB is therefore shown and the constructor is left to his or her own devices here. Stripboard would make a suitable alternative to a custom built PCB for the LEDs, or they could be mounted onto the front panel using LED clips and have wires soldered directly to their legs.

The LEDs should be wired to the shift register outputs in reverse order, as I shall now explain. The outputs of the first shift register IC are numbered Q0 to Q7 and, for convenience, let us call the outputs of the other registers Q8 to Q15 and Q16 to Q23 for ICs 6 and 7 respectively. Q0 drives the green LED via R7, while the other outputs drive red LEDs via resistors, whose numbers are derived by adding J00 to the output number, e.g. Q9 is connected to R109. The LED connection points are, for clarity, not labelled on the layout of the main board in Figure 6, but their numbers are implied by the numbers of the resistors closest to them. Let us now suppose that we have, for example, five remote circuits which are numbered in the natural order along the chain, as in Figure 1. This is the case which is used for the circuit diagram in Figure 7, so ICs 6 & 7 and resistors R106 and above are not used. The LEDs are connected in reverse order to their series resistors, such that LED1 is fed from R105 and LED5 from R101. This is necessary because the first bit into the shift register moves through to the last output used.

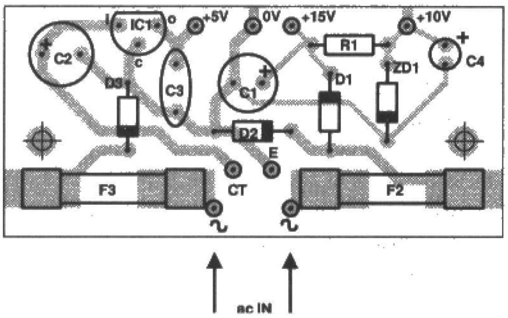

Fig.10 Mains PSU component overlay

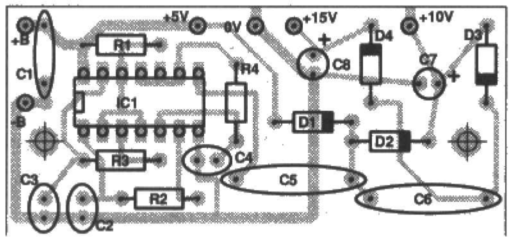

Fig.11 Battery PSU component overlay

A wire must be fitted between point (near C4 at the centre of the main board) and the shift register output following the last one used for an LED. For the example given above, this will be Q6.

The remote circuits are connected to each other and to the base unit by a three core cable. The prototype uses a stereo jack plug and socket, but these connections may be hard wired via a terminal block or soldered directly onto the PCB. The type of cable used is not critical.

The window switches may be reed switch/magnet combinations of the type commonly used in security systems, or a miniature reed switch can be mounted directly onto the remote PCB.

Points S1 and S3 on the remote circuit board are provided for this purpose. The assembly can then be housed in a small plastic box and used with a suitable magnet. Take care to orient the reed switch correctly if you choose this option.

The last remote circuit of the chain is terminated by a 5.6k resistor. This is in addition to the switch, and should be fitted between the output and a 0V terminal.

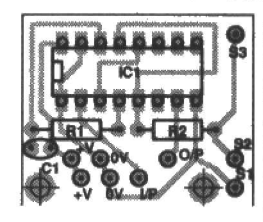

Fig.12 Remote circuit layout

The mains powered version of the monitor has the transformer, mains switch and mains fuse F1 mounted off board, so that there is no mains voltage on the PCB. A double pole switch and a shrouded panel mounted fuse holder are recommended for the above. If a metal case is used, then it should be earthed. The LT fuses F2 and F3, are mounted by fuse clips. Holes for these are not shown because clips vary in design and the mounting hole positions will depend upon the type of clips which you use.

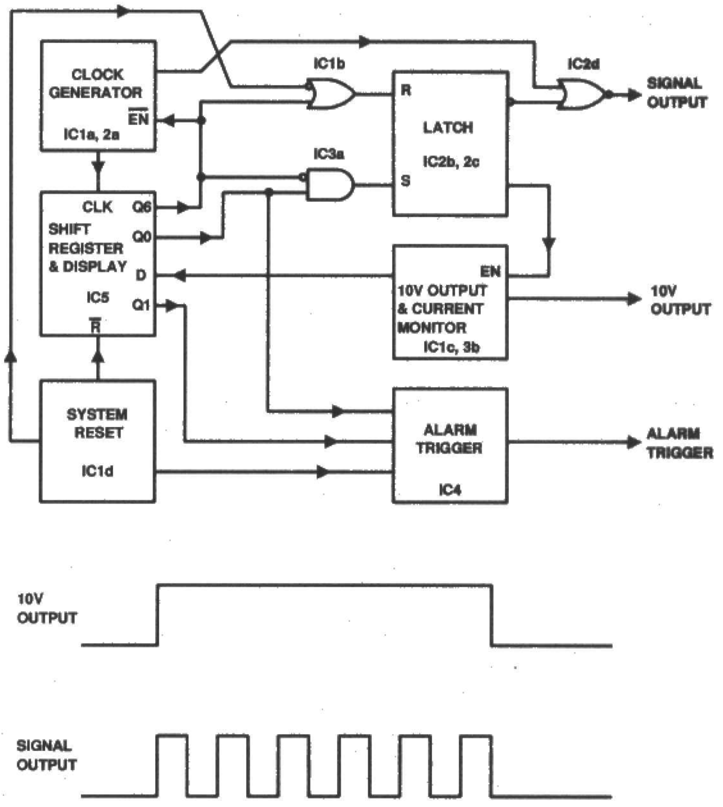

Fig.13 Main circuit block diagram and waveforms

D1	D0	Q0	Q1	Q2	Q3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Fig.14 Truth table, 2 to 4 Line decoder (1/2 of 4555)

A single pole on-off switch will suffice for the battery powered version. A push-to-make type would be appropriate where intermittent rather than continuous operation is required.

PARTS LIST

MAIN CIRCUIT

RESISTORS

R1,2,10,11,12,14,15	56k
R3,6,23	10k
R4,8,9,13	27k
R5	100k
R7	1k8
R16	33k
R17	220k
R18	15k
R19	1k
R20	270k
R21	120k
R22	82k
R24	560k
R25	2k2
R26	47k

CAPACITORS

C1	4n7
C2	10n
C3	1µ/10V
C4	100n

SEMICONDUCTORS

IC1	LM339
IC2	4001
IC3	LM358
IC4	4011
IC5	74HC164
Q1	BC547
D1-4	1N4148
LED1-5	Red LED
LED6	Green

MAINS PSU

RESISTORS

R1	1k2

CAPACITORS

C1	100µ/25V
C2	470µ/10V
C3	100n
C4	10µ/16V

SEMICONDUCTORS

D1-3	1N4001
ZD1	BZY88C10V

MISCELLANEOUS

T1	240V/6-0-6V 100mA transformer
F1	63mA, QB fuse
F2,3	100mA, 20mm, QB fuses

BATTERY PSU

RESISTORS

R1	1k
R2-4	10k
C1	100n
C2-4	220p
C5,6	220n
C7,8	4µ7/25V

SEMICONDUCTORS

IC1	74AC00
D1-4	1N4148

BUYLINES

All of the components used in this project are readily available, with the possible exception of the 74AC00 IC used in the battery PSU. This is stocked by Maplin. Other logic families cannot be substituted because CMOS types have insufficient output current drive and TTL types have insufficient output voltage swing. Other AC series inverting gates may be used, but would require the PCB to be redesigned.

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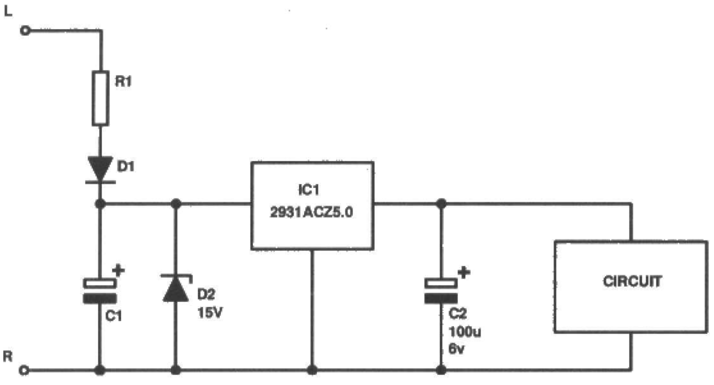

Fig.1

The normal way to power an electronic project is either to use batteries or a mains transformer, rectifier, smoothing capacitor, and voltage regulator. This is fine for many projects, where the circuitry has to be isolated from the mains, or where it draws a substantial current. However, there are instances where the current requirement is very small and the circuitry will never be touched, meaning that the project can be connected to the mains. Maybe the circuitry is already connected to the mains, because it controls a triac. In these applications, a mains transformer is unnecessarily costly and bulky and a direct mains power supply is preferable.

Resistive Supplies

The most obvious type of direct power supply is the resistive type, as illustrated in Figures 1 and 2. In broad terms, the circuit of Figure 1 works by half wave rectifying the mains via a current limiting resistor. The resulting dc voltage is stored on the reservoir capacitor C1.

The voltage on C1 is limited by the zener D2 and is regulated down to 5V by IC1. IC1 is a voltage regulator with very low quiescent current, so as not to waste the scarce available current from this supply. If the supply is intended to run circuitry which does not require a very smooth or accurate power source, IC1 and C2 can be omitted.

The question is: how much current is available? Clearly, the lower the value of the resistor, the higher will be the available current and the hotter the resistor will become. The limit to the heat dissipation of the resistor may be determined by the resistor ratings, or it may be limited by the ventilation of the enclosure in which the circuit is housed.

Let's take a practical example. Assume we can use a 10W resistor, but want to limit the dissipation to 8W under worst case conditions, to give an adequate safety margin. If there were no diode in series with the resistor, the dissipation would simply be $Vrms^2/R$. Because the diode conducts for half the cycle, the dissipation is halved.

For a mains voltage of 264V (a 240V supply, 10% too high), the resistance giving 8W dissipation would be 4356R. Oddly enough, this precise value is unavailable in normal resistor types, but 4k7 is available. A 10% 4k7 resistor would have a resistance min of 4230R, giving a maximum possible dissipation of 8.2W. This is quite good enough, particularly considering that these approximate calculations have neglected the load voltage, which reduces the peak voltage across the resistor and therefore reduces the dissipation by (probably) enough to keep within the specified dissipation under a worst case situation.

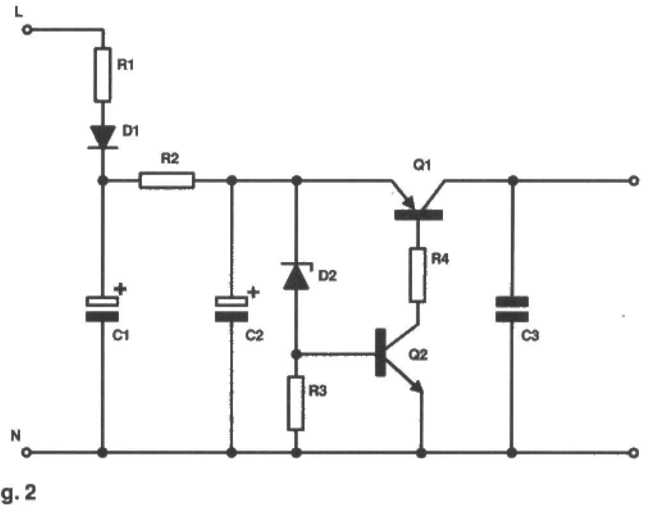

fig. 2

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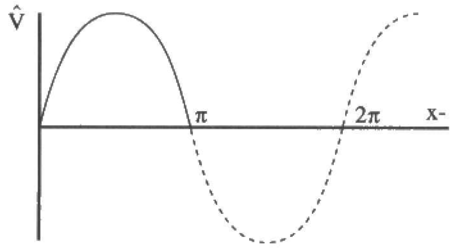


$$I_{av} = \frac{1}{2\pi} \times \frac{\hat{V}}{R1} \times \int_0^{\pi} \sin(x)dx$$

$$= \frac{\hat{V}}{2 \times \pi \times R1} [\cos(x)]_{-1}^{+1}$$

$$= \frac{\hat{V}}{R1} \times \frac{1}{\pi}$$

Fig.3

Direct Current

The next question is, how much direct current is available from this power supply? It is tempting to make the assumption that the DC available is equal to half the AC that would flow in the resistor R1, if R1 were simply connected across the mains. This is not the case, however, as is illustrated by Figure 3. Current flows in the resistor for half the time (neglecting the small offset due to the DC output voltage) and, in order to calculate the average direct current available it is necessary to average the current in R1 over a whole mains cycle, even though the current is only flowing during positive half-cycles.

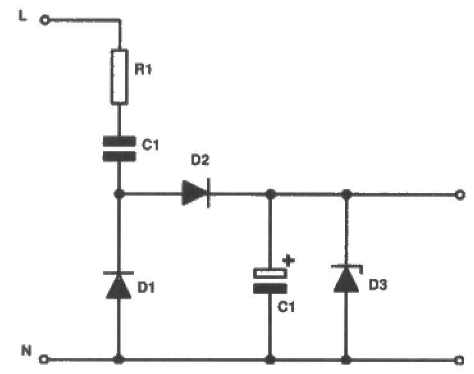


Fig.4

Looking at the maths shown in Figure 3, the way to calculate the average current over a mains cycle is to calculate the average over a half-cycle and then to divide by one cycle, working in radians. The formula shown consists of three main elements: the division by 2π averages the current over a whole mains cycle, the V/R term calculates the peak current flowing in R1 and the integral term integrates a half-sinusoid of current over a half-cycle. The final answer is that the average direct current available is equal to the peak current in the resistor divided by π. Therefore, for a 240V mains supply with a 4k7 resistor, as in the example above, a current of 23mA is available.

In order to avoid the circuit failing to operate under all conditions, it would be prudent to design around the minimum current which could be available, taking into account a below- standard mains supply and subtracting from this the dc voltage at the bottom of D1. A 15% low mains supply would be 204V, so, subtracting the zener diode voltage we are left with 189V. The peak voltage is now 267V, giving an available current of 18mA. If we allow 4mA to be wasted in the zener and the voltage regulator, then the load circuit can be allowed to draw 14mA without any danger of it failing to work.

The circuits of Figure 1 and Figure 2 are very similar in effect, but the circuit of Figure 1 will always provide an output voltage even if there is not enough current available for the supply to reach its proper voltage. In some cases, this can be harmful. If, for example, the circuit is controlling triacs switching an inductive load, then inadequate power-supply could result in the triacs only triggering on (say) positive mains half-cycles. This would destroy load or triac or both.

The circuit of Figure 2 provides slightly poorer regulation, as it relies upon the voltage characteristics of a zener diode in series with a base-emitter junction of a transistor. It does, however, cut off the output supply completely if the mains is inadequate to provide a regulated output. This can be helpful in some circumstances.

Capacitive supplies

A disadvantage of power supply circuits like these is that the resistor dissipates a lot of power. If the circuit is to be built into a plastic case, this can become an acute problem. Another way to limit an alternating current, and one which does not result in any dissipation, is to use a capacitor. A power supply of this type is shown in Figure 4. Note that the surge- current in the capacitor at switch-on is limited by R1 and that two diodes are provided in order to permit an alternating current to flow. If D1 were omitted, then C1 would charge to the peak mains voltage, after which no further current would flow in D2.

The disadvantage of this type of circuit is that a capacitor with full mains voltage across it can be prone to failure, unless a high-quality component is used. What tends to happen is that because the electric field across the dielectric is constantly reversing, any weak spot in the plastic film which forms the dielectric for most mains-rated capacitors is worn out over a period of time. As a slight digression, some authorities hold that paper capacitors of nominally the same rating are more reliable.

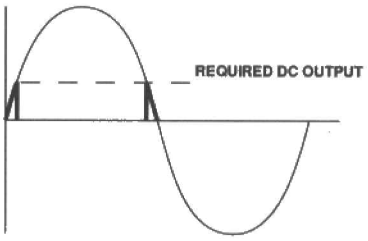


Fig.5

In any case, a class X capacitor (rated for direct connection across the mains) should be used in this type of supply.

Once again, the question arises of how much direct current is available from this type of supply. The same reasoning as was applied to the resistive supply will suit the capacitive supply as well. To calculate the direct current available, we divide the peak current by π. (Remember that only one-half of the mains cycle contributes to the DC output.)

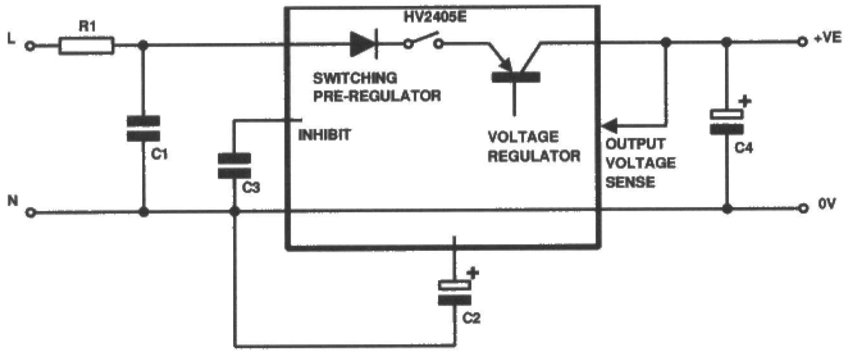


Fig.6

Here is an example, showing the current available if a 220 nanofarad capacitor is used.

$$I_{ac} = V_{rms}\ \ 2 \times \pi \times f \times c$$

So for 240V , with a 220nF capacitor,

$$I_{ac} = 240 \times 2 \times \lambda \times 50 \times 220 \times 10^{-9}$$

$$= 16.58mA$$

$$Peak\ current = 16.58 \times \sqrt{2} = 23.46$$

$$DC\ available = \frac{23.46}{\pi} = 7.47mA$$

The available current, 7.47mA, is disappointingly low, but a useful amount of current can be obtained if two or three of these capacitors are put in parallel. It is also the case that there are some application circuits that would not need more than seven milliamps to operate.

Switching supplies

A completely different approach to a low-dissipation transformerless power supply is illustrated in Figure 5. This diagram shows the mains voltage waveform with a current drawn only near to the zero crossings on the positive half-cycle. With this scheme, a storage capacitor is charged to whatever power supply voltage is required through the expedient of switching off the charging current while the mains voltage is above the required capacitor voltage. I have seen this scheme used in several applications, not all starting at mains voltage.

While it is possible to do this job with discrete circuitry, the easiest way is to use a standard chip which has been developed for the purpose, the HV2405E. Figure 6 shows the general operating scheme which the chip uses.

R1 limits the surge current and should be chosen so that the peak current at peak mains voltage could not exceed 2.5A. C1 is a spike-suppression capacitor, which should have a minimum value of 47n on normal mains applications. C2 is the main storage capacitor which is charged to a sufficient voltage to operate the output regulator. C3 is there simply to prevent the internal circuitry of the chip falsely triggering on mains interference.

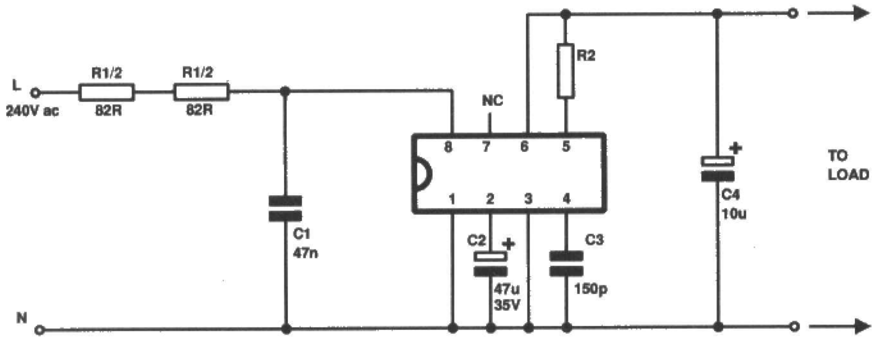
The switching pre-regulator charges C2 to a maximum of 10V above the output voltage. There is then always enough voltage to power the output voltage regulator, which is rated at a maximum of 50 mA. The primary purpose of the output capacitor is to suppress spike interference which could occur on the charging point of C2. A minimum value of 1 µF is required, but higher values will provide better suppression.

Figure 7 shows a practical circuit designed for use on 240V mains. The output voltage is set by the value of R2, at 5V plus 1V/kohm. Thus, for example, if R2 is short circuited, the output will be 5V and if R2 is 1k, the output will be 6V. The maximum allowable output voltage is 24V.

Conclusion

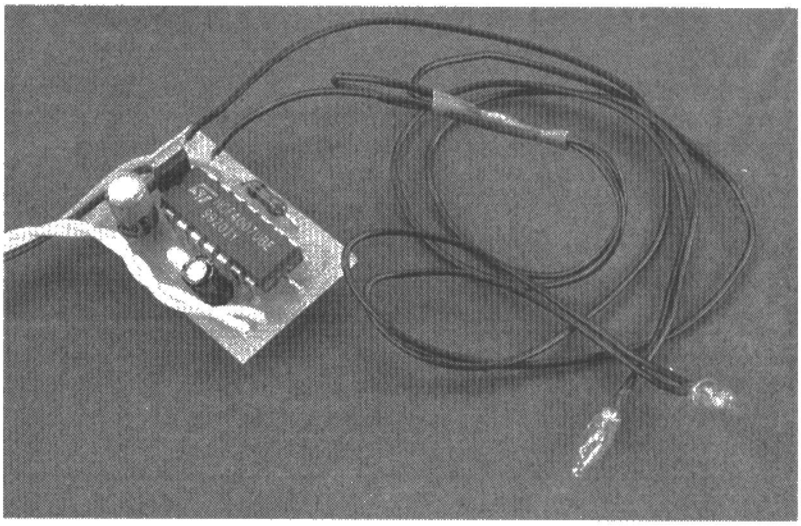
As this article shows, there are a number of ways to provide modest low-voltage power-supply currents without the use of a mains transformer. This can save both cost and weight. The only absolute requirement to power equipment in this way is that it must be safe and appropriate for the equipment to be at mains potential. For example, the circuitry of a remote-controlled light dimmer would be a suitable item to power in this way, but an audio preamplifier would not. When building circuits of this nature, it is important to remember that even the low-voltage parts are at mains potential and appropriate care must be taken in building, testing and using such items.

NOTE:-
FIG 6
—
FIG 7
pin Nos.
RELATE TO
FIG. 6



R1 = 135R min
C1 = 47n class X
C2 = 470u, (Vout +10V)
C3 = 150p
C4 = 1u min

Fig.7



Brake Lights For Radio Controlled Models

By A Craig Talbot

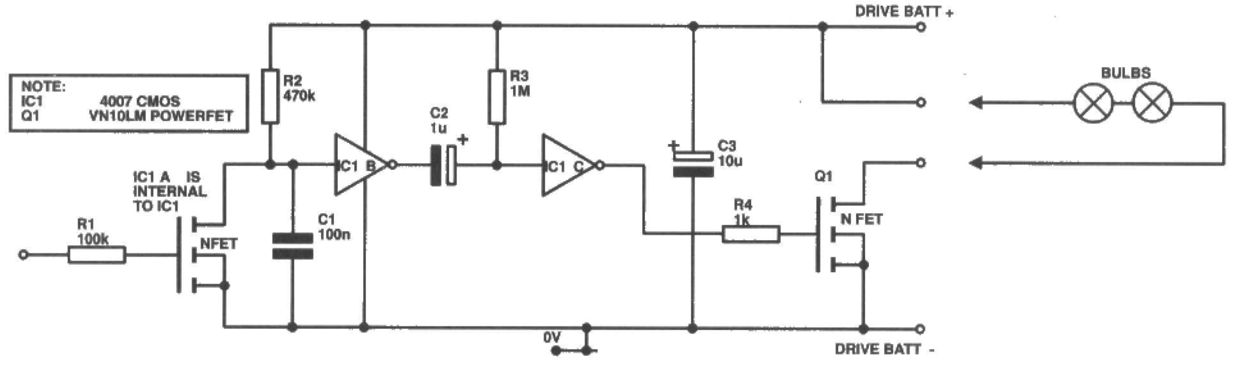


Fig.1 Brake light circuit

Some time ago, while contemplating the building of my 1/16 Scale Model Truck, I decided on a range of what might be described as 'extras'. In addition to the normal electronic Speed Control, I wanted direction indicators, reversing warning sound, headlights, spotlights, engine sound, a flashing beacon (wide load warning) and working brake-lights. As the model has no brakes, I could not operate any mechanical system to switch them on or off. The only way to accomplish this was to use the Speed Control to trigger them in some way.

The circuit described here is designed as an add-on to the Low Power Speed Controller, described in a previous issue. It will give a brief (about 1 second) pulse of light whenever the vehicle stops, goes through a forward to reverse, or a reverse to forward function. The PCB is tiny enough for all but the most diminutive model and while it can, of course, be built on something like Veroboard, the PCB is only postage stamp size and it would be difficult to build it much smaller. CMOS was used because of its low standby current - after all, a brake light is not often switched on. It is also very suitable for the drive battery range, 6 to 12V. For a scale model car, or truck, in fact any land vehicle that represents a road legal original, brake-lights that work are a feature that will add interest to your model. They cost little and employ a very simple circuit, so if you need them, have a go.

HOW IT WORKS

The circuit in Figure 1 uses a 4007 IC, which consists of an inverter and t
complimentary pairs of FETs in a package which allows most of the nodes of t
FETs to be accessed. Because of this feature, one complementary pair of FE
can be wired as a second inverter and one N channel FET can be selected to a
as a switch. This will discharge C1 whenever the input to it is positive, or whenev
it is receiving positive pulses. The pulses, in this case, are generated by t
Speed Controller (at the point marked 'X'). By this action, it will stop C1 chargi
up via R2, until the positive pulses or positive level on the input are removed. Th
will happen only when the Speed Controller is in a stop condition. As you can se
C1 will charge through R2 as soon as the internal FET (in IC1) is switched off. Th

Construction

As IC1(4007) and Q1 are both FET devices, care should be taken in handling them as they are sensitive to damage by static charges. Observe the normal handling precautions with these devices. The bulbs need a little thought as to which voltage you are using, since the original Speed Controller can be built as either a 6V or a 12V version. This means that two 3V bulbs in series will be required for 6V, or two 6V in series for 12V. If you elected to use an unusual voltage you will have to work it out for yourself.

The current rating of the bulbs must be kept below 300mA and, if you decide on parallel connections to the bulbs, then the bulb current will obviously have to be kept below 150mA. This board has several fine tracks that run between the IC pads and care must be taken with your soldering to ensure that no solder bridges are formed. Use a fine pointed bit.

Take a good look at Figure 2, the component overlay. Notice the resistor R2 tucked under the PowerFET Q1 and the two resistors under the IC. This more or less dictates that the resistors must be fitted first on this project. Ensure that R1 and R4 are 1/8W types and are fitted hard down on the PCB surface. This will allow the IC to seat as low as is possible, leaving some leg to solder. I would suggest that IC1 and Q1 come next. Remember not to handle them more than is required (if you don't have the luxury of a conductive mat, try raiding the kitchen for a length of aluminium foil, but do remove it before connecting any battery volts). Care will have to be taken in fitting the IC because of the resistors beneath it. The IC will not sit as close as normal to the PCB, leaving a reduced length of the leg to solder, so make sure that the IC is level, thus ensuring that the same length of leg protrudes through the PCB at each pin. When IC1 and Q1 are in place, the capacitors can be fitted, noting the polarity of C2 and C3, clearly marked on Figure 2.

There are a couple of wires to the brake-light bulbs from the points marked 'Bulbs'. The neat bit of wiring is to the Low Power Speed Controller so you should temporarily disconnect the drive battery, then fit a red wire from +ve on the PCB to the dead side of the Power switch in the Drive Battery positive lead (so that the circuit can be switched off), and a black one from -ve on the PCB to Drive Battery negative. There's one more wire from the point marked 'In' on the PCB (this will eventually go to the Speed Controller at the point marked 'X' after a brief test). That's the construction of the PCB completed, so now check for the solder bridges that I mentioned at the beginning. If, like me, you use reading glasses, a magnifying glass may be useful. When you are sure that all is as it should be, we can go on to test.

will cause the input of the first inverter in the circuit to go positive, making its output swing negative. This negative change will be passed across C2 causing the input of the next inverter to go negative, making its output positive, which will turn on the PowerFET (Q1) and hence turn on the light.

The light will stay on until C2 is discharged back too positive by the action of R3, making the gate change state and driving its output back to negative. This will switch off the PowerFET (Q1). R1 is to limit the input current into the gate of the internal FET. R4 serves the same purpose for Q1. C4 is a small decoupler for the power rail, which is a pulse omission detector, followed by a one shot, or monostable. By using this IC, a very simple circuit using very few (and low cost) components is produced. The overall result is a short pulse of light from the brake-lights when we want one and very little current being drawn when the light is off. This is the kind of circuit I like best - no surplus Hi-Tech, just the bare minimum and no waste. That covers the basic circuit description so now it's time to warm up the soldering iron and start to build.

Testing

At this point, the Drive Battery should be re-connected. Switch the power on to the PCB. The bulbs should briefly light up (about 1 second) then go off. That is a sort of power up reset. The next job is to switch off and connect the wire from the point marked In, to the Speed Controller at the point marked X (see inter-PCB wiring, Figure 3). If you are keen, you will probably have switched on and tried by the time you read the following!

With that last connection, this circuit is now a part of the Speed Controller. The final test will have to be with the radio control gear. When up and running, the bulbs should light, briefly, whenever you go to stop or through the stop position on the control stick. Not a lot to test, was there?

Heat-shrink tubing or even a short length of plastic insulation tape will encapsulate this little PCB. It would also make a good subject for potting in a suitable potting box.

In Conclusion

The addition of any feature on a model adds to its pleasure and value, personally I feel that the less they cost, the more the pleasure. If you wish, a small model can use 3mm or 5mm Red Light Emitting Diodes (LEDs) instead of bulbs. For this, wire two Super Bright Red LEDs and a resistor, all in series (don't forget the polarity of the LEDs). The resistor should he 100R for 6V and 390R for 12V. I find that translucent, rather than opaque types, look best. It should be possible to use this circuit with other relay reversing, pulse speed controllers, by using pulses from the drive transistor/s that drive the motor, provided that they are positive going and of suitable amplitude, but this is something that I have not personally tried.

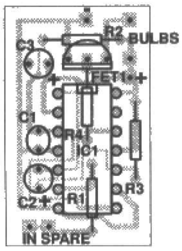


Fig.2 Component Overlay

Any situation in which you require positive pulse detection can use this type of circuit. The pulse repetition frequency that you wish to detect can be accommodated by changing the values of R2 and C1. Likewise, changing the value of R3 and/or C2 will lengthen or shorten the light On time.

A Little Extra

Now, as a bonus, how would you like to fit reversing lights? If so, read on.

The Speed Controller is capable of driving a couple of small bulbs in addition to the Relay, when switched to reverse (i.e. when the relay is called). All that is required is to add a wire to the point marked Y which should be connected via two bulbs to the dead side of the switch in the Drive Battery Positive lead. The bulbs should be selected in exactly the same way as the ones used for the brake-lights except that the current rating must not exceed 100 mA. This applies to all Controllers running at Drive Battery voltages from 6V to 12V. This will allow the 300mA relay drive PowerFET Q1 to drive both loads together without being over-driven. Should the bulbs light while in forward, the wires to the motor should be reversed.

Another feature that can be added at the point marked Y on the speed controller, which applies to trucks in particular, is reversing sound. The reversing sound that you will have heard when juggernauts reverse can be produced by a small piezo ceramic sounder, connected instead of the reversing bulbs. The type with its own built in oscillator, that produces a pulsed tone, is required for this. Again, the 100mA current limitation should be observed.

A point to note is that some of these devices produce very

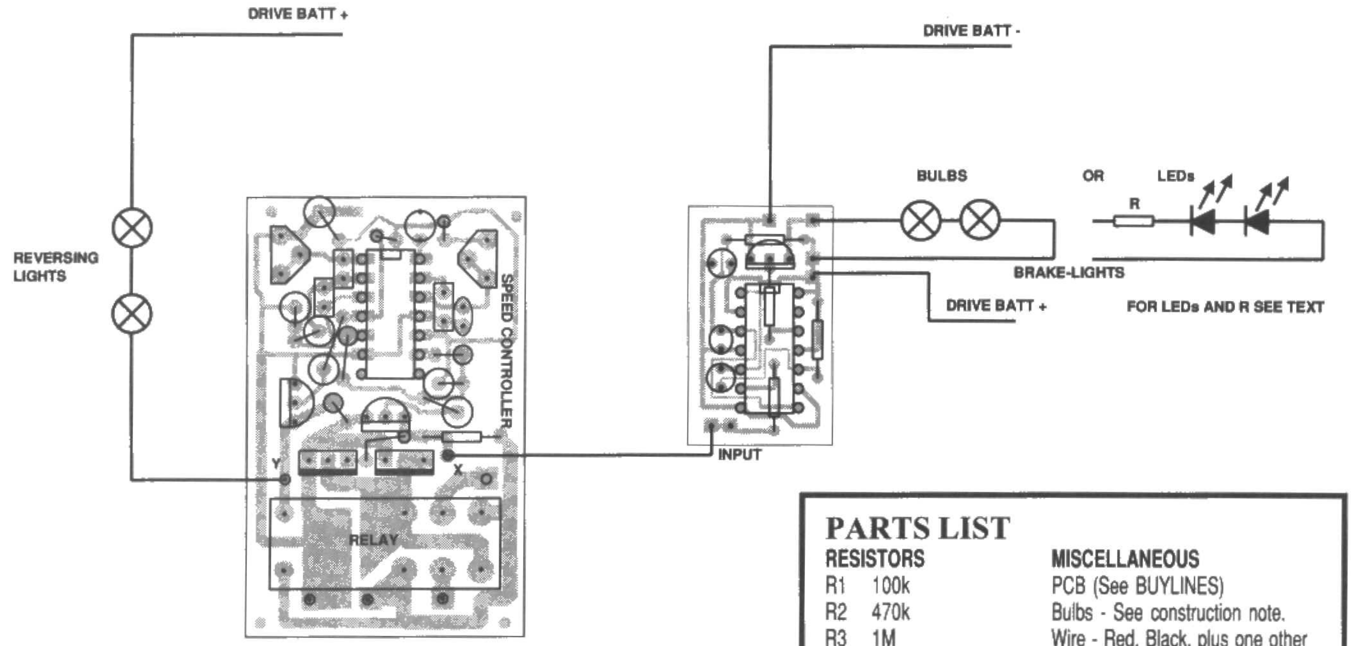


Fig.3 Board interconnections

high output levels on 12V, too loud for some applications. To overcome this, all that is needed is to cover, or partly cover, the sound hole with a strip of tape. This will dramatically reduce the level. The high frequency of these sounders is of the same order of frequencies used on some full size trucks.

Well, that's the project done, along with a few extras. I hope you enjoy building it and that it will add something special to your model.

PARTS LIST

RESISTORS

R1	100k
R2	470k
R3	1M
R4	1k

CAPACITORS

C1	100n
C2	1u/16V
C3	10u/1.6V

SEMICONDUCTORS

IC1	4007 CMOS
Q1	VN10LM PowerFET

MISCELLANEOUS

PCB (See BUYLINES)
Bulbs - See construction note.
Wire - Red, Black, plus one other colour to suit

BUYLINES

The brake light PCB is available from
ACTion. 140 Holme Court Avenue
Biggleswade
Bedfordshire
SG18 8PB
Price £1.80
Plus £0.50 Postage & Handling.
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Measuring Light Spectra

by Douglas Clarkson

New technology is increasingly making use of 'optical' processes and, as a result, there is an increased need to be able to make measurements of a wide range of 'optical' parameters, such as power output of sources as a function of wavelength and the transmission and reflection properties of materials as a function of wavelength.

While, in a strict sense, 'optical' can be considered to relate to visible wavelengths of light between 400nm and 700nm, in practice the term is applied to wavelengths below 400nm (into the ultra violet) and above 700nm (infra red). The bulk of optical communications technology, for example, uses wavelengths around 1500nm. In this field, there is an obvious need to be able to accurately measure the optical properties of fibres as they are manufactured and installed.

Increasingly, optical components such as filters, lenses, reflection coatings, photodiodes, photomultiplier tubes, etc. are being used in new products and services and there is an expanding need to be able to accurately determine the optical properties of such items.

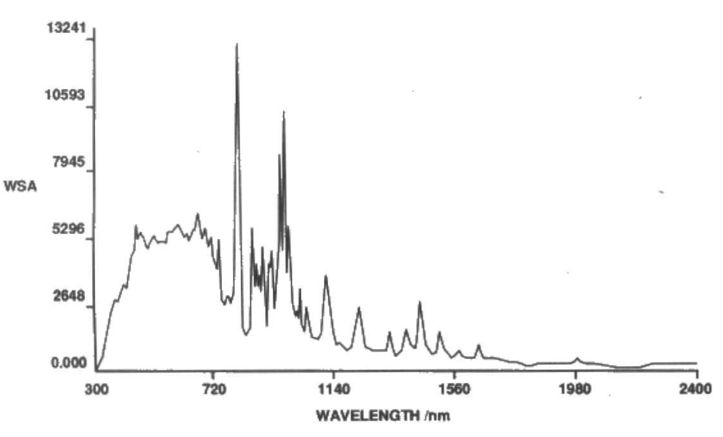

Fig.2 Spectral output of a solar simulator, indicating the high level of complexity of the spectrum (Courtesy Rees Instruments Ltd)

Figure 1 shows the absorption properties of three samples of doped glass as a function of wavelength. There are absorption peaks at around 450nm and 700nm and it is often important to be able to measure such parameters in this way. Figure 2 shows the measured output of a solar simulator. Clearly, only by measuring the spectral output in relatively narrow wavelength bands is it possible to determine the output from the lamp. In addition, there is often the need to capture spectrum data rapidly. The excitation process can be initiated and completed in timescales of hundreds of micro seconds.

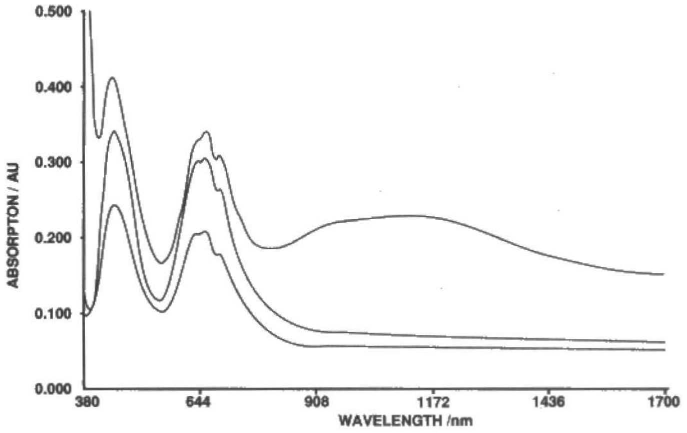

Fig.1 Values of absorption properties of samples of doped glass (Courtesy Rees Instruments Ltd)

Optical Measurement - A Multi-Dimensional Problem

In voltage measurements, the problem is typically one of resolving voltage values with time - i.e. one parameter is being monitored at successive time intervals. In spectral analysis, there are many more independent values to measure. The spectrum of a typical light source from 400nm to 1200nm is in fact a continuum of wavelengths, which may be scanned over wavelength extents averaged over 2nm, 1nm or 0.5nm - so there may be 400, 800 or 1600 independent measurements to be made to determine the spectrum present.

Conventional Approaches - Splitting the Spectra

Optical radiation presents typically as a range of wavelengths. Thus, a standard tungsten lamp will have a spectrum between 390nm and 1300nm. Specific lasers, such as Argon lasers, present a selection of lines of specific radiation - in the case of Argon mainly around 580nm.

Light can be split into its various wavelength components using either a prism or a diffraction grating. The 'traditional' piece of equipment for spectrum analysis is the monochromator, the basic design of which is shown in Figure 3. Although the device shown is a Spectrograph, which can split the spectrum and present it at a long exit slit, in the monochromator the diffraction grating is rotated (with indication of wavelength selected) and a portion of the output spectra passed through a narrow output slit. The

Monochromator itself does not include any equipment to measure the output of the spectra which are emitted. The mirrors in the system have typical efficiencies of 90%. Gold mirrors, with reflectivities of around 97%, can be used for infra red wavelengths.

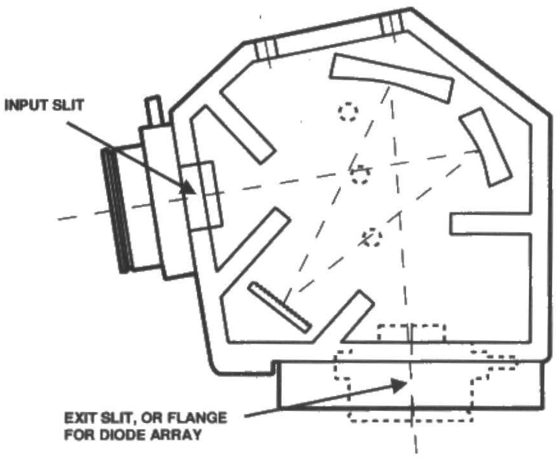

Fig.3 Principle of Monochromator. The diffraction grating is usually rotated by hand and the light output emerges through an output slit. The device shown is, in fact, a Spectrograph manufactured by Oriel where a complete spectrum can be passed to a long narrow exit slit (Spectrograph mode) or a single range of wavelengths can be selected (Monochromator mode).

Light incident on a diffraction grating is split into a series of orders about the main angle of reflection, as shown in figure 4a. Typically, most light is passed into the +1 or -1 order. To improve the amount of light passed into one of the first orders, the surface of the grating is cut in the 'blazed' pattern indicated in Figure 4b. This blazing process, while optimising the efficiency of the grating at a specific wavelength, makes the grating more 'angular sensitive' and limits the spread of wavelengths which can be used. Typically, a grating optimised for use at 500nm can be used between 2/3 and 3/2 of its optimised wavelength - in the case of the 500nm example, between 330nm and 750nm.

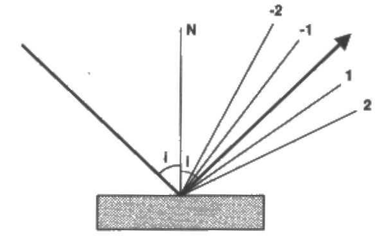

Fig.4a Process of diffraction of light by a reflection grating into different orders +2, +1, 0, -1 and -2

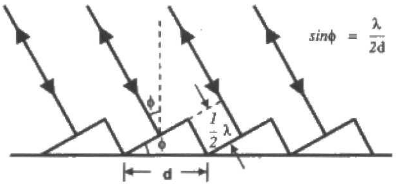

Fig.4b Geometry of 'blazed' grating, to optimise output into the +1 order

Conventional gratings are produced by cutting a master using diamond cutting tips. This invariably introduces an element of random error into the grating performance which results in 'stray light' - light which is reflected in error into the order of the grating being scanned.

Holographic gratings produced by the interference of two coherent light sources, can be used to produced gratings which, while having much less stray light (as little as 1% of that of a ruled grating), have a reduced efficiency because they are not 'blazed', i.e. cut to optimise a specific order. This can be of value where measurements are being made of optical materials with high values of optical densities.

Light enters the unit via a pair of slits and is split typically by the diffraction grating. An emergent portion of the spectrum can be selected by rotating the diffraction grating a known extent. This rotation of the grating can be undertaken by hand or through a stepper motor and can be driven between extreme limits. The emergent light will contain a narrow band of wavelengths dependent on the size of output slit, the line numbers per cm of the diffraction grating and the general optics of the system. The smaller the slit and the greater the number of lines per cm on the diffraction grating, then the more selective the monochromator will be.

The width of the wavelengths present will vary typically from 0.5nm to 2nm, depending on the design and construction of the monochromator.

Introducing Rapid Measurements: Spinning Monochromators

The mechanical motion of such a basic design of monochromator is, however, not convenient for many applications where a complete spectrum is required rapidly. The previous 'standard' monochromator, for example, could typically be rotated across its spectra in about a minute. In many applications, such as production line checking of optical components, test results are required much more rapidly.

One option is to rapidly rotate the diffraction grating so that the spectrum is rapidly swept past the output slit. This is the technique used in the Rees Instruments Spectrum analyser whose spinning grating monochromator is shown in Figure 5. A single photodetector device is present at the output slit and the spectrum is constantly rotated past the output slit, which provides a system with a relatively low cost photodetector device that can be selected to match the particular application.

This approach provides flexibility in it's 'mix and match' of needs to available detectors and diffraction gratings and the system can be optimised for any part of the spectrum between 200nm and 15,000nm. The speed with which a spectrum can be obtained is limited by the speed of rotation of the DC motor driving the diffraction grating. At present, a single spectrum can be measured in 80ms with this particular model. Usually a He-Ne laser is used to provide a wavelength reference.

Figure 6 shows the spectral response of a 6118/7 detector - a nine stage photomultiplier tube used with the Rees system. In the photomultiplier tube, electrons are emitted from a light sensitive surface and then cascaded down an avalanche of voltage steps, where each stage increases the number of electrons released. Such a detector has a much higher sensitivity, about 70 A/W (peak), compared with a conventional photodiode detector's 0.5 A/W (peak). The photomultiplier detector can be used with narrow output slits in order to provide better resolution of measured spectra.

An uncooled silicon photodiode typically covers the wavelength range between 190nm and 1100nm. An uncooled germanium photodiode covers the range between 600nm and 1900nm while the uncooled lead selenide photoconductive cell covers the range between 1500nm and 4500nm. Thus, needs for specific applications can be met, although there is no universal photodetector which will span all the wavelengths which are required.

Introducing Rapid Measurements: Static Spectra

Developments in semiconductor chip technology have made possible the rapid scanning of complete spectra in short time scales with the absence of spinning diffraction gratings. The technique, however, cannot at present be used for wavelengths in excess of 1100nm.

Figure 7 shows how a linear diode array can be used as a 'static' system for the scanning of an optical spectrum. The light enters the system through the pair of entrance slits and is diffracted by the diffraction grating. The spectrum is incident on the diode array in discrete segments, typically 2.5mm high by 25 microns wide and 25 microns apart. Such a diode array may have 128, 256, 512 or 1024 elements and minimum exposure times of from 5ms to 16.5ms. Thus, the smaller the diode array element, the longer the minimum exposure time. The electron sensitivity of a diode element could be 3500 electrons per count with the wavelength range able to scan ranges from 180nm to 1100nm.

In this mode of spectral analysis, the light is processed into its spectral components by a Spectrograph - the entire spectrum is made available at the exit slit to be read by the solid state linear array of CCD. The solid state detector unit is simply bolted onto the spectrograph output slit structure (Figure 4) and interfaced to a PC via a specialised interface card.

The great advantage of this type of system is that there are no moving parts and the spectrum can be sampled rapidly by reading out the voltage sensed by the various discrete diode elements. Systems can, in addition, be configured to scan a smaller sub set of diode elements more frequently. A scan repetition rate of 25 micro seconds can be achieved by use of special random-access type diode arrays to access specific elements of the diode array.

Linear arrays function on a charge integration basis, where the charge released by electrons being released by the photoelectric effect (light photons release electrons) is accumulated over a specific time period and then reset when a specific pixel's data is read. The so called dark current is the current which flows in 'dark' conditions and it can set a limit on the exposure time during which measurements are made. In low cost linear array systems the dark current at room temperature is around 1pA and the total saturation charge of a diode element is around 7pA - giving a maximum exposure time of around 10 seconds. Diode arrays of a higher specification and which can be cooled either by liquid nitrogen or thermoelectrically by a Thermoelectric Cooler, allow longer integration times. Such improved diodes have a higher saturation charge and a smaller dark current of around 0.01pA - providing integration times of 25 minutes at temperatures of around -10°C.

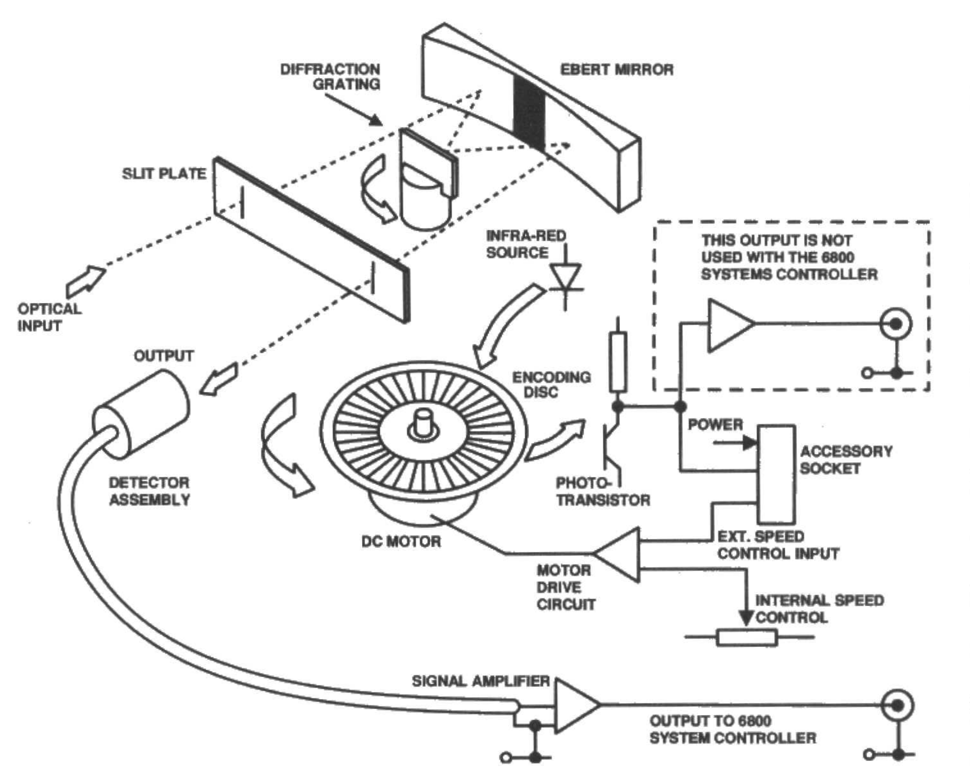

Fig.5 Technique of spinning Monochromator for rapid scanning of spectra (Courtesy Rees Instruments Ltd)

Charge Coupled Device Technology (CCD)

This linear diode array gives a one dimensional view of a specific spectrum, which can be considered as an N x 1 array. There are applications, however, where several spectra are required to be analysed in parallel. The charge coupled device can be considered to be a N x M array, where several spectra which have been processed independently by a diffraction element, can be identified separately on the CCD. CCDs are now produced with in excess of 1024 x 1024 elements.

Figure 8 shows a series of four separate fibre optic inputs which are independently split by means of a spectrograph to produce four separate spectra on the CCD. On a typical CCD unit, of a 1024 by 256 array, each spectrum will typically be contained with a separate array area of 1024 pixels wide by about 64 high. The resulting value for a particular element of the array will be obtained by summing the 64 elements (y axis) at a specific one of the 1024 elements (x axis). Each pixel is typically 22 x 22 microns and systems are now available which can process up to 35 independent spectra on a single CCD element.

The greatly increased sensitivity of CCD devices allows data from experiments to be obtained much more rapidly compared with conventional photomultiplier systems.

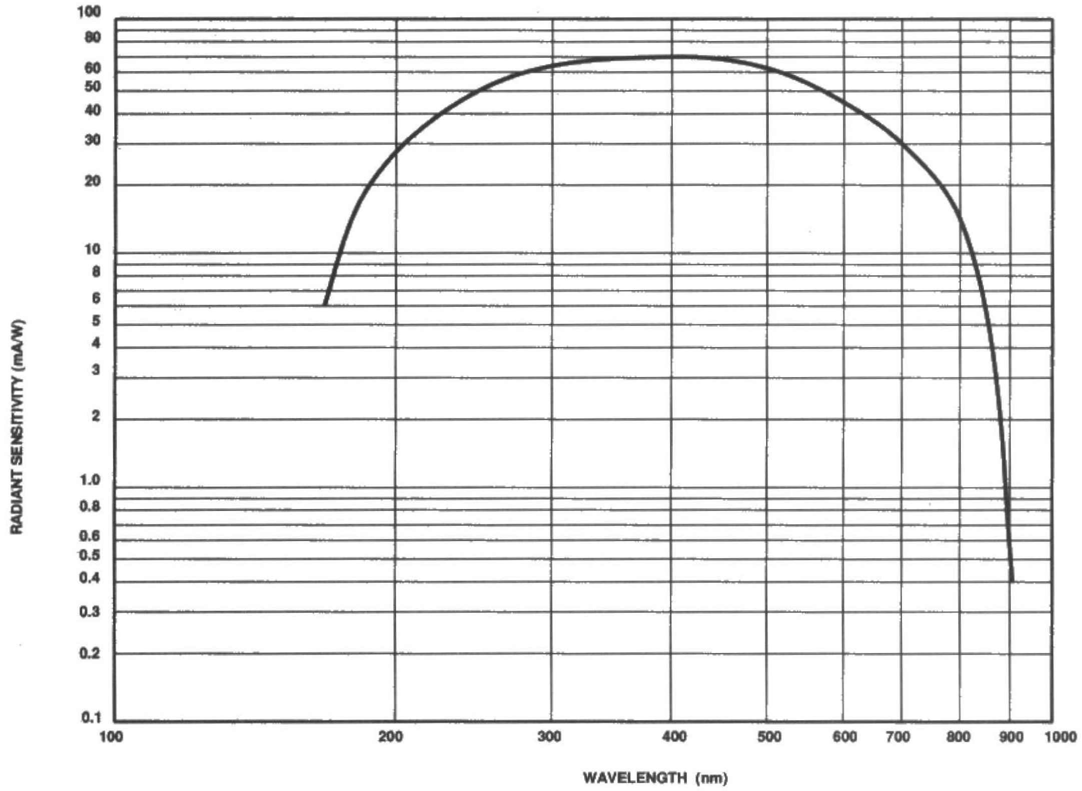

Fig.6 Spectral response of a photomultiplier tube (Rees Instruments 6118/7) which provides significantly greater sensitivity compared with silicon photodiodes

The wavelength response of CCDs is shown in Figure 9. UV enhancement can extend the response down to lower wavelengths (300 microns) but sensitivity falls sharply above 1000nm. Thus, CCD technology cannot at present be used effectively for spectral analysis above this limit. With spinning monochromators, however, the wavelength range can be extended up to 15nm using detectors such as Mercury Cadmium Telluride (MCT).

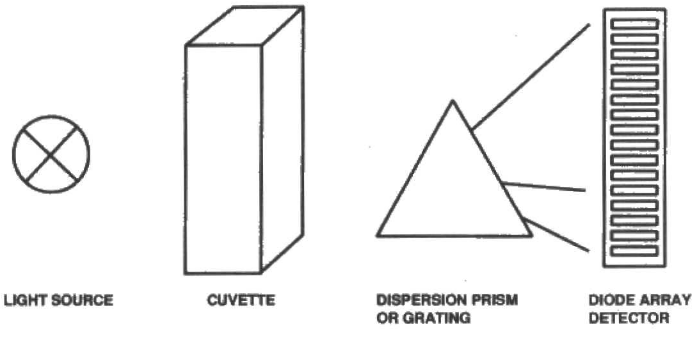

Fig.7 Use of 'static' spectral analysis system, where incident light is diffracted using a static diffraction grating and the output is detected by a stationary linear diode array

The scanning rate of such a complete CCD unit is 40Hz, with the display being updated at 20Hz, although individual pixels can be accessed in fractions of micro seconds.

The technology of the Charge Coupled Device, however, is radically different from that of linear diode arrays and consequently CCDs tend to be expensive. Useful CCDs tend to cost in excess of £15,000 - just for the chip.

They do, however, have an unsurpassed sensitivity. One of the most sensitive units has a sensitivity of 10 light photons to produce one count, several hundred times more sensitive than a conventional linear diode array. CCDs are being developed generally for high quality image data capture. Applications in Astronomy, where extremely weak light sources are being imaged, are particularly relevant.

Dynamic Range

The dynamic range of a spectral analysis system is based on the resolution of its A/D converter subsystem. The common value for resolution is 16 bits - 1 in 65536, while the lowest values tend to be 14 bits - 1 in 16384. The greatest dynamic range, however, is provided with systems incorporating CCD units, where an 18 bit resolution - 1 in 262144 - tends to be standard and 22 bit resolution - 1 in 4194304 - is 'top of the range'.

It is obviously important to have as high a dynamic range as possible. If, for example, the absorption properties of a material were being investigated, a system with a higher dynamic range is going to be able to directly measure higher levels of optical density.

Conclusion

Developments in several areas of technology have made optical spectral analysis more affordable and subsequent developments are likely to increase the range of features which can be implemented at an acceptable cost. A low specification system interfaced to a PC may cost around £10,000. While the ability to measure light spectra is of vital commercial importance, it is also important that such measurement techniques are available within the educational sector, in order to focus awareness on a vital area of future economic growth. Such systems do not necessarily need to be so expensive or complex. A specification such as a wavelength 2nm resolution between 250nm and 750nm, with 12 bit dynamic range and a spectrum able to be produced in 10 seconds would be a useful starting point - educational scientific designers and manufacturers should take note.

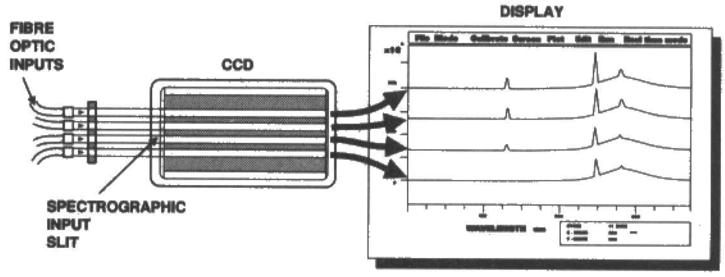

Fig.8 Use of a CCD to record four simultaneous spectra: in this example each spectrum is mapped to a specific region of the CCD surface

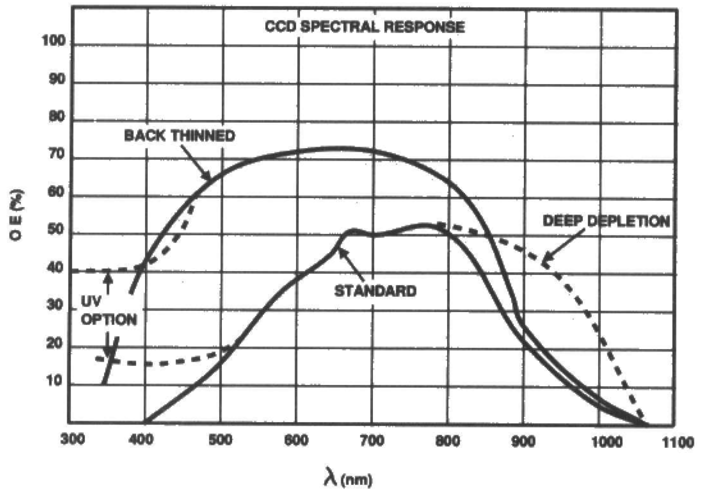

Fig.9 Typical Quantum efficiency of CCD units. Specific options of back thinning, deep depletion or UV enhancement can improve performance as indicated.

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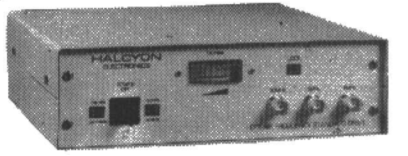

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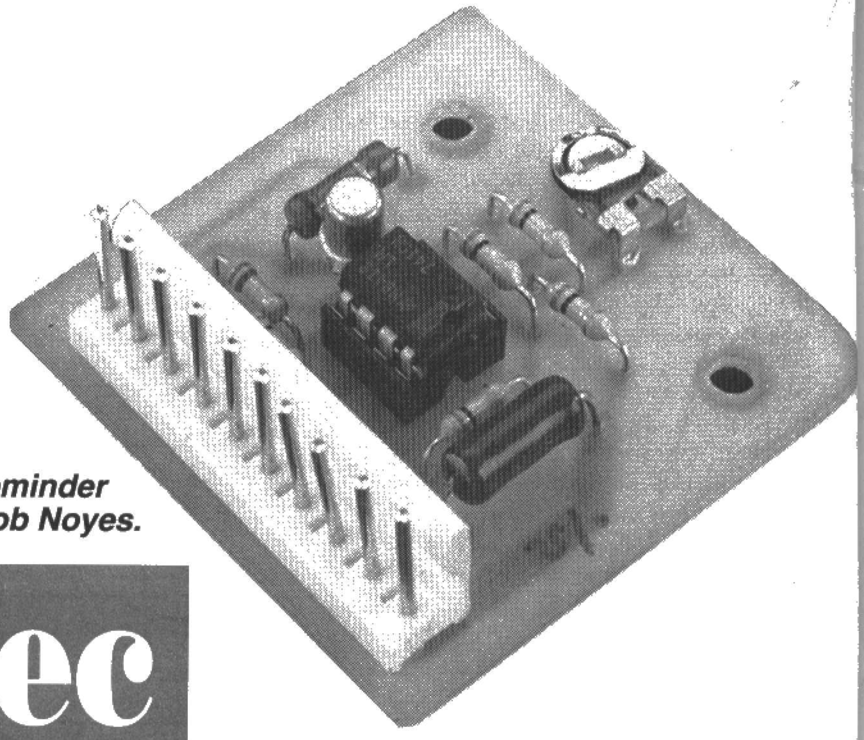


A car light failure reminder
by Bob Noyes.

Lumitec

“Oi mate, did you know one of your brake lights is out?” It’s good when someone alerts you to the fact, but more often than not you can be driving around for weeks without knowing your lights aren’t working properly. And how many times have you followed a car at night and noticed that only one tail light is working, thinking “how dangerous, I wonder if my lights are OK”? In a perfect world, everyone should regularly check their cars out for the basics but it’s not perfect and a lot of us don’t bother. How nice it would be to have an audible warning when a tail light failed - it would bring peace of mind, for as well as increasing safety it would help you to keep your car ‘legal’.

One of the tail lights on my car failed a couple of months ago and I didn’t know about it until my son spotted it, so I decided to design a simple circuit - ‘Lumitec’ - to monitor the power going to the bulbs. A small resistance is inserted into the power positive wire to the bulb in question and, when the bulb is powered, a small volt drop is experienced across the resistor. Because of the relatively high currents, this series resistor is very small. For the brake lamps/indicators, 0.05R is recommended and for the tail lamps, 0.1R. When in operation, less than 200mV is dropped across these resistors so the brightness is not noticeably affected and the power dissipation in these series resistors is minimal.

The output can either illuminate an LED or sound a buzzer, or both. The buzzer is preferable because an LED can illuminate and not be noticed, whereas a buzzer attracts immediate attention.

Fitting And Setting

Because this board is going to work in a car where condensation can be a problem, the tracks should be cleaned of flux and sprayed with a PCB lacquer, to protect the copper

HOW IT WORKS

As indicated before, a small value sense resistor is inserted, into the positive side of the bulb in question. The size of this resistor depends upon the current in the circuit being monitored. The value of the resistor should be chosen so that when the bulb(s) are on, a voltage of no more than 200mV is developed across it. To give some indication of values, here is a table of currents, powers and so forth.

	BULB POWER WATTS	CURRENT AMPS	RESISTOR OHMS	PD VOLTS	POWER WATTS
Brakes	2 x 21	4	0.05	200mV	0.8
Indicators	21	2	0.05	100mV	0.2
Tail Lamps	2 x 5	1	0.1	100mV	0.1

These values are only an indicator, as battery voltages vary depending upon age, charging rates, etc. and bulbs vary in power depending upon age and state of wiring, etc..

The current in the amps column is the steady current if the bulb is left on, but such bulbs as indicators and brake lights are constantly switched on and off. When a bulb is cold, its resistance is much lower, so a high current pulse flows until it warms up. This pulse can be several times the steady state value so, where fixed value resistors are fitted, the power ratings are much higher than normal. 2.5W wire wound has been used and no problems have been experienced.

A 741 op-amp is used as a voltage comparitor, to compare the voltages either side of the sense resistor. As op-amps do not like sensing at their rail voltage, both sides of the sense resistor are potentially divided down to approx. 1/2V so the sensing is done around 6V. The +ve side of the sense resistor is used as the supply for the op-amp, because it cannot be turned on all the time or it will give an indication that the brake lamp bulb has blown when the brake has not been activated Each of the sense circuits is individually powered only when the appropriate bulb is powered. The centre of the potential divider, R4-R5, on the +ve side of the sense resistor R1 is connected to pin 2 (inverting input) while a small variable resistor, 1k RV1, is fitted in the middle of the bulb side potential divider, R2-R3. This will allow for any tolerance incompatibilities in R2, R3, R4 and R5 to be cancelled out. The centre of the preset is taken to Pin 3 of the op amp - the Non-inverting input. The setting of this variable resistor is critical for the correct operation of the circuit.

When the circuit is working correctly, the voltage presented at Pin 3 of the op-amp is slightly below that at Pin 2, because the volts drop across R1 due to the current of the bulb(s).

When one of the bulbs, if there are two, or the bulb if there is only one tracks from corrosion.

The 4-way Lumitec has been designed to fit at the back of a car behind the lamp assembly. Most cars have a left and right rear light assembly where all the lamps are mounted in one block - a loom comes in from the front of the car to either the left or right assembly and is connected to the other via a short loom (as per diagram).

The wires on the rear of the light assembly can be identified simply by seeing where they go and can be confirmed by monitoring the voltage on each pin when various lights are activated. Because these assemblies usually have special connectors, it is best to leave them well alone and cut the wire several inches up the loom - enough to allow the wire to pass through into the box containing Lumitec and fitting the female insulated spade connector which plugs directly onto the PCB. If desired, Lumitec can be connected to a connector block and the wires connected from the connector block into the loom. All cars are different and it is a matter of taking great care with all the wires by not letting them short and checking that all wiring and connectors are of sufficient current carrying capacity (see table). The buzzer can be mounted in the rear of the car, but in the boot the sound might not be detected, so the best place for it is under the dash. A wire is taken from Pin E up to the dash to the buzzer and, for safety, the +ve side of the buzzer has an inline fuse - 500mA up to the ignition switched side. The single channel Lumitec can be mounted anywhere, such as behind the dash with the LED output mounted on the dash, but the buzzer should also be connected. To find the correct wire to monitor any given light the car's circuit diagram should be consulted. If you're still not sure, ask at your local garage.

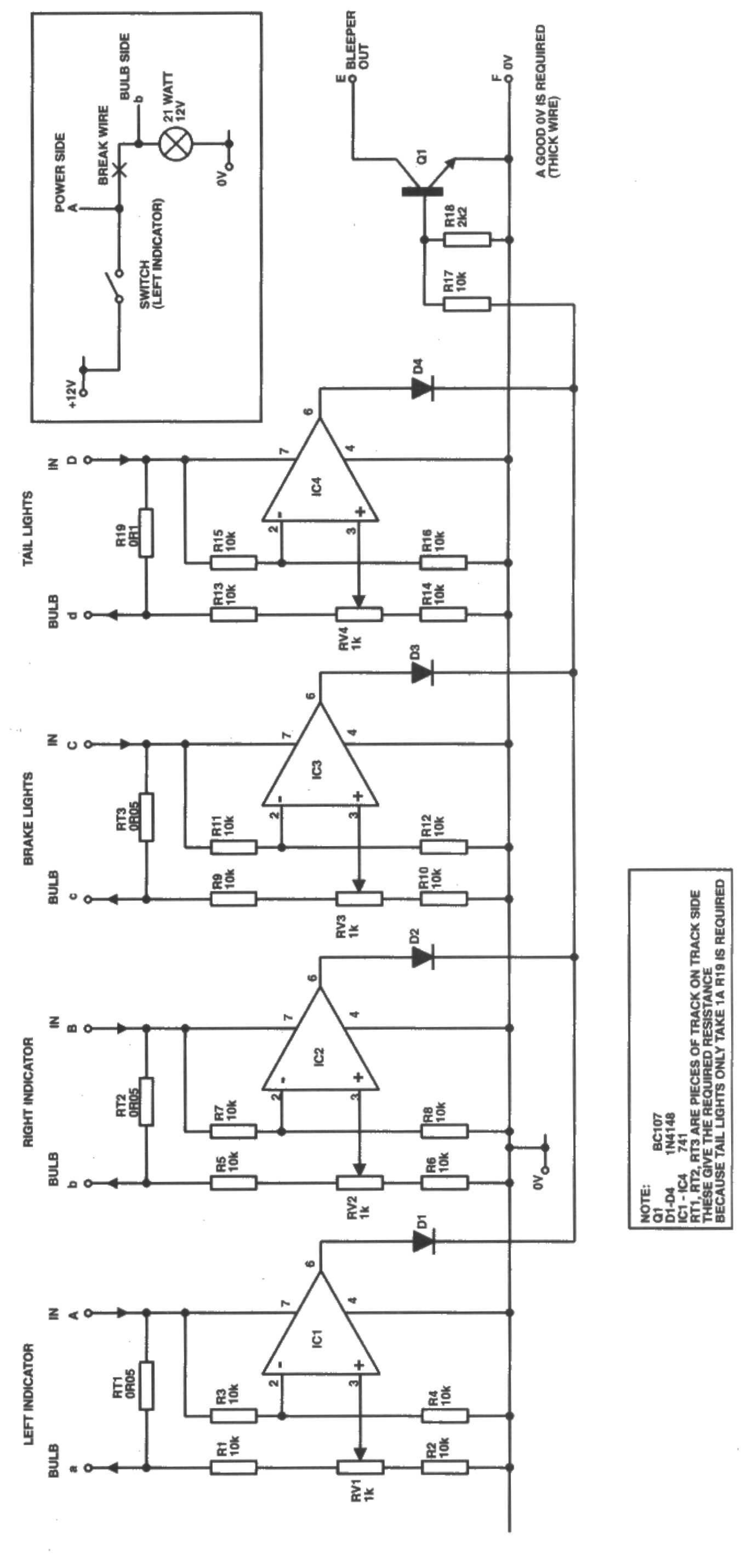
A good earth (0V) connection is required, do not use the bulb common. Wire direct to the chassis

blows, the current through R1 will reduce. This in turn means that the voltage at Pin 3 of the op-amp is no longer lower than Pin 2 and the output of the op amp will go from its normal low to a high. This turns on Q1, which in turn activates the buzzer, the +ve of which goes to the ignition switched side, i.e. at 12V when the car is in motion.

To save on buzzers, a 4-channel block has been designed, the operation of which is exactly the same as the smaller single channel, but the outputs are connected via diodes to one drive transistor, Q1. This in turn goes to the buzzer and again the +ve side of the buzzer goes to the ignition switched side.

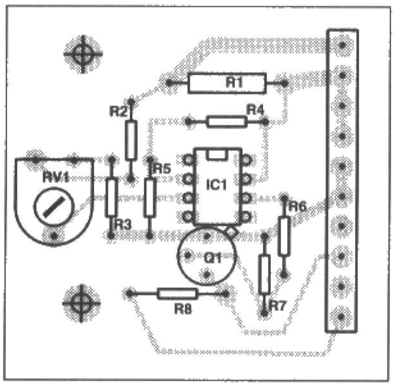
Because of the size of the 4-way Lumitec, the sense resistors have been formed by the PCB track. This saves fitting power resistors on the brake light and both indicators, but because of the relatively high value 0.1R for the tail light, a resistor, R19, is still required.

Although the first three circuits of the 4-way Lumitec look the same, the length of track that forms the sense resistors differs. That is why the shortest piece of track, channel 3, is used as the brake monitor, as this normally has around 4amps through it, so a smaller track length is required to drop the required sense voltage.



NOTE:
Q1 BC107
D1-D4 1N4148
IC1 - IC4 741
RT1, RT2, RT3 ARE PIECES OF TRACK ON TRACK SIDE
THESE GIVE THE REQUIRED RESISTANCE
BECAUSE TAIL LIGHTS ONLY TAKE 1A R19 IS REQUIRED

Fig.1 Four channel circuit



NOTE:
10 WAY CONNECTOR 0.156 BLOCK MALE PINS
10 WAY CONNECTOR MAY BE REPLACED BY SOLDER PINS
FOR R1 SEE TEXT

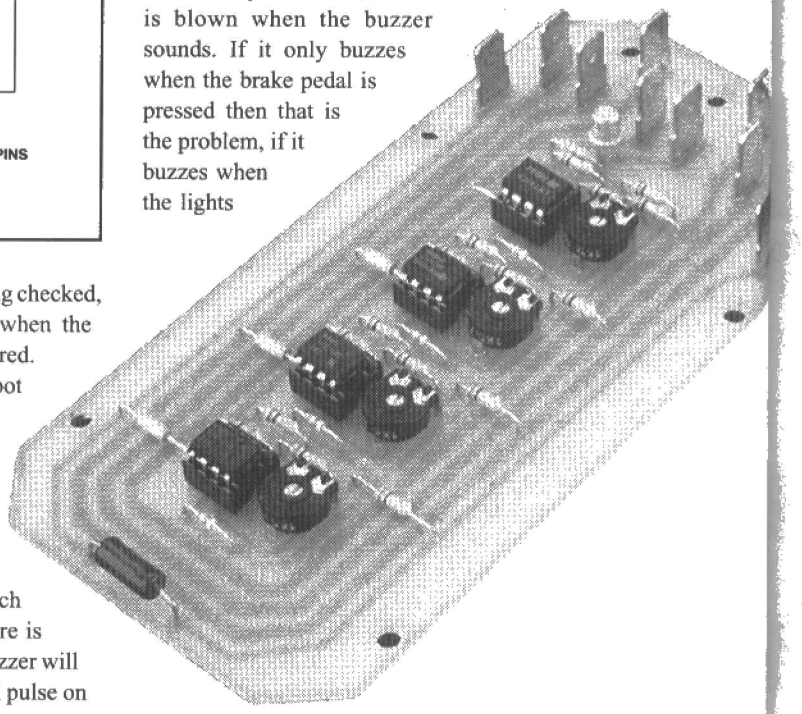
Fig.2 Single channel overlay

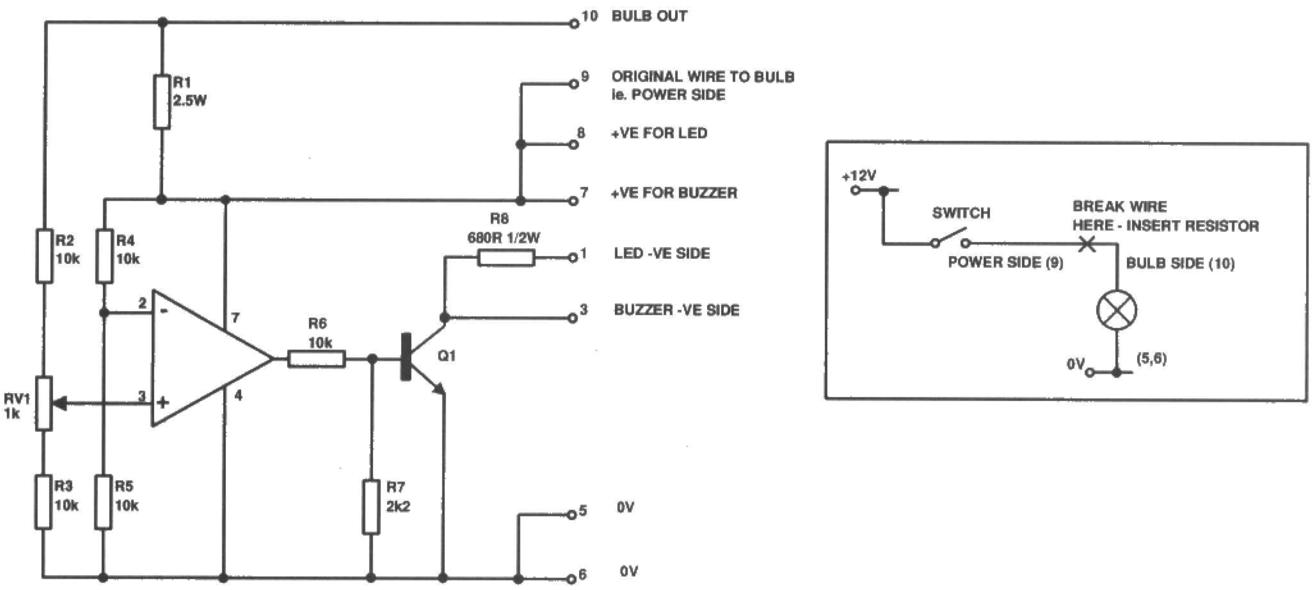
and, once the Lumitec has been fitted and the wiring checked, the RV is adjusted so that the buzzer sounds when the appropriate bulb is removed and the circuit powered.

In the case of the brake and tail lights, the pot should be set so that the buzzer sounds when one of the bulbs is removed. Assuming normal 5% resistors have been used, the pot should be set in the centre as a rough guide and adjusted to sound when the bulb is removed and the circuit is powered.

Each circuit is set up one at a time. This is much easier with the indicators because at the rear there is only one bulb on each circuit. The output of the buzzer will only bleep when the lamp should be on, i.e. it will pulse on and off at the indicator speed (normally slower when a bulb is dead or removed). When all of these have been adjusted, drive around the block to check they work in all combinations - sometimes a slight readjustment may be required. When you're happy with the settings, the pots can be sealed with a small dab of paint - this will stop the vibration of the car from adjusting the presets - then fit the lid. The box can either be mounted or laid in the shell of the car. Care should be taken that no strain is put on the wires and that it doesn't vibrate in motion.

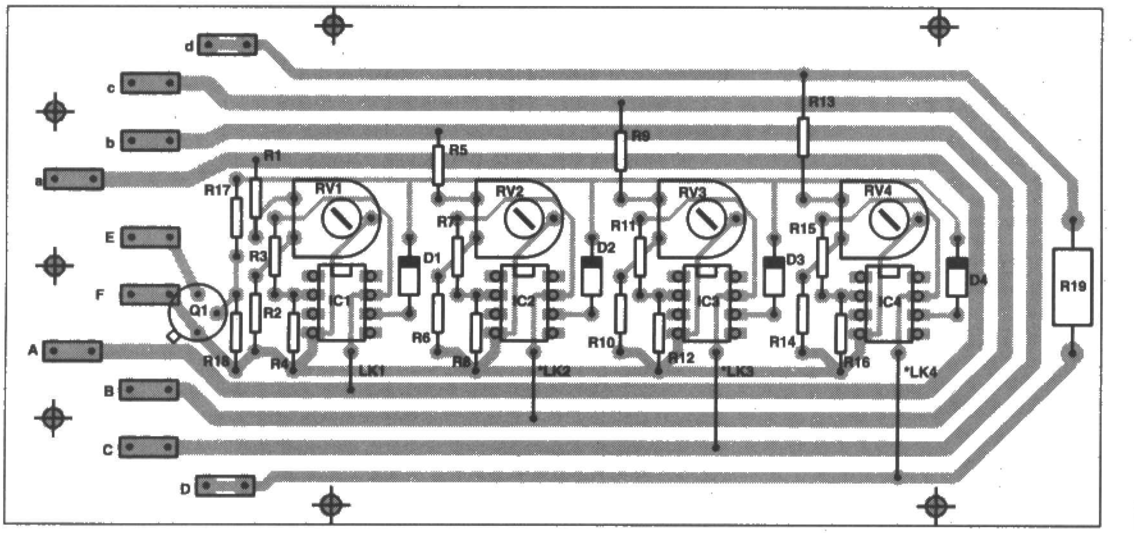
It is easy to detect which bulb is blown when the buzzer sounds. If it only buzzes when the brake pedal is pressed then that is the problem, if it buzzes when the lights





NOTE:
Q1 BC107
IC1 741
R1 SELECT FOR MAX OF 200mV ACROSS R1 ON LOAD
TAIL LIGHTS, SIDE LIGHTS 0R1 2.5W
INDICATORS, BRAKES 0R05 2.5W

Fig.3 Single channel version of circuit



NOTE:
*LK2, LK3, LK4 MAY BE REPLACED BY ZERO OHM RESISTOR TYPE LINKS
▭ MALE SPADE CONNECTORS
⌖ MOUNTING BOLT HOLES
CORNERS MAY HAVE TO BE REMOVED TO FIT BOX

Fig.4 4 channel overlay

are on that gives it away. The sound of the buzzer is annoying, so it should encourage you to replace a dud bulb quickly - not a bad thing from the safety aspect but it should reduce the risk of being stopped by the police.

NB. With the brake or tail lights the buzzer does not sound immediately. This is because although one bulb may have failed, the other one draws a high current pulse which is high enough not to trip the comparitor on switch on. When the bulb settles down to its steady state current, the buzzer sounds. This circuit has been designed for the rear lights, although the single channel unit could be fitted to the front side lights.

The headlights should not be monitored as they draw much more current - 60 watts each - which is around 10amps steady state. The heated rear windows should not be connected to this circuit because some of these draw around 20amps - far beyond the capabilities of this circuit as presented here, although the same monitoring principles apply.

Wire Rating

Before any work is done, check the currents expected. These wire ratings may help:

16/0.2 mm	**0.5mm**	**3A**
24/0.2 mm	**0.75mm**	**6A**
32/0.2mm	**1.0 mm**	**10A**

PARTS LIST

SINGLE CHANNEL VERSION

RESISTORS

R1	see text	
R2-6	10k	
R7	2k2	
R8	680R	1/2W
RV1	1k preset	

SEMICONDUCTORS

Q1	BC107
IC1	741

MISCELLANEOUS

ABS box, e.g. Maplin Cat No. LH20W
M3 nuts and bolts to suit

4 CHANNEL VERSION

R1-17	10k	
R18	2k2	
R19	0R1	2.5W
RV1-4	1k preset	

SEMICONDUCTORS

Q1	BC107
D1-4	1N4148
IC1-4	741

MISCELLANEOUS

ABS box 2005, e.g. Maplin Cat No. LH61R
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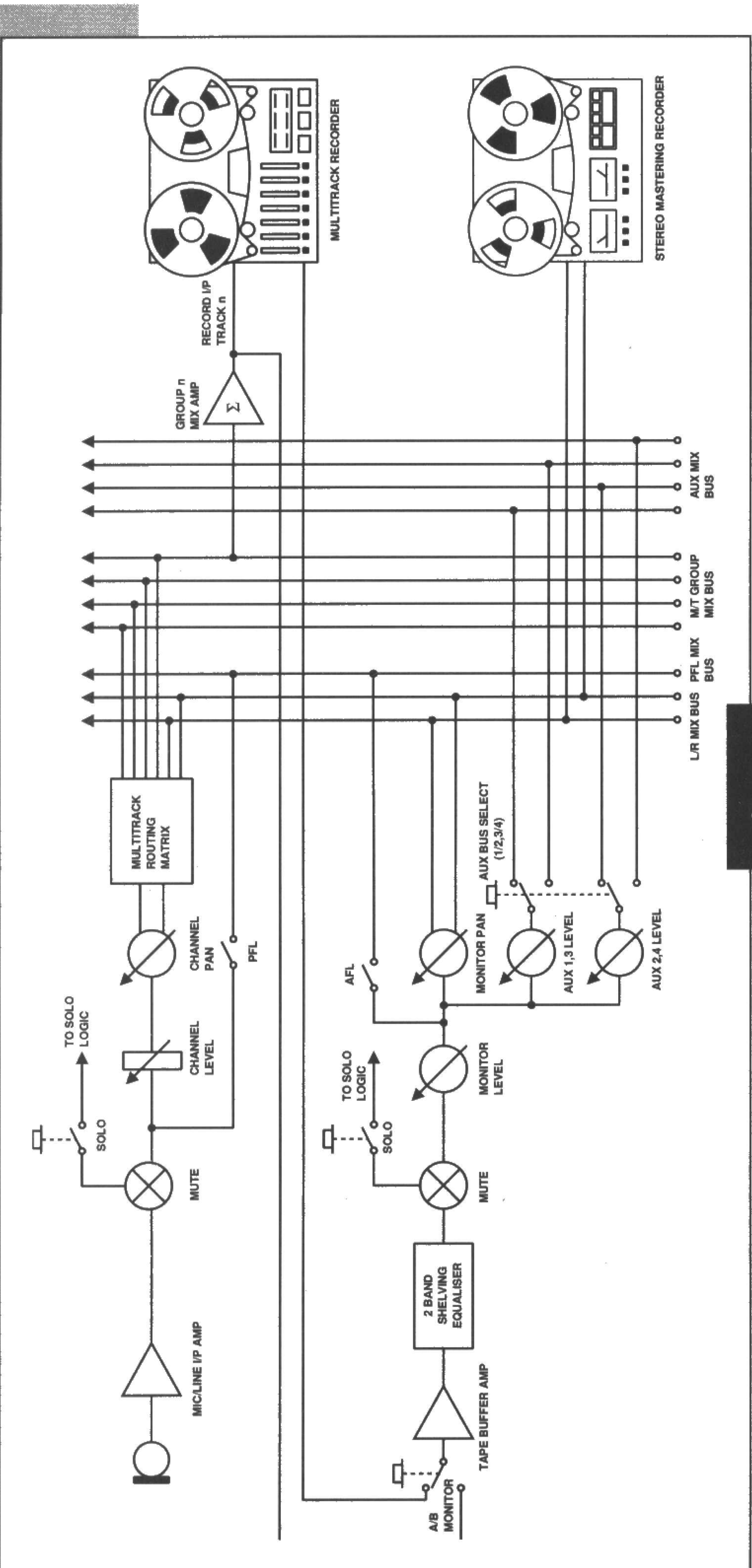


Fig.1 Split desk showing simplified input section and monitor section

by Mike Meechan

In this latest part of the AutoMate series, we're going to look at routing and some of the devious paths along which audio must pass, on its way from microphone to stereo master via the multitrack recorder.

Routing deals with switches (and other controls, as we'll discover later) which determine the audio pathway within the console architecture, whether it is in the channel itself, on or off the mix busses, or out of the mixer completely. It also encompasses such mundane but necessary functions as the switching in and out of equalisers, filters and dynamics processors.

Evolution of the In-Line Console

On any multitrack recording desk, it must always be possible to monitor the input or recording signal on each of the separate tracks, be there four, eight, sixteen or whatever. A mix, both of what is going on to tape and what is down already is then presented to the monitor loudspeakers as a reasonable representation of the final stereo mix. This is the so-called monitor mix. For us to be able to achieve this, there has to be made available some method of inputting each track taken off-tape into the console. Conventionally, this is known as off-tape monitoring, B check or tape machine return. Controls to manipulate level, spatial positioning (pan) and perhaps FX send levels must also be provided in any comprehensive system. See Figure 1.

Anniver

Further, we must be able to monitor the track return in isolation (provision of more Solo monitoring points) and perhaps also create foldback mixes from the signals coming off tape, thus allowing a feed of the machine sync. signal or the line input signal to be sent to the artist's headphones. The recorder electronics may be used to effect this switching (most incorporate logic switching/audio routing systems which are smart enough to achieve this easily) or there may be a Monitor A/B switch associated with each track on the monitor channel (in normal studio convention, A is the Record or input side of the

sary AutoMate Mixer

tape signal and B is the Replay or output side). Much depends on the console designers overall pricing strategy and the kind of machines which he envisages being connected to the desk. Limited EQ (normally LF and HF shelving types) is also sometimes provided. Figure 1 shows a typical split configuration desk.

With reference to the above, it is easy to see that many of the monitoring facilities attributable to the machine returns are, in fact, similar or identical to those which constitute the mixer input channel. To this end, it is not unusual for multitrack desks to have an entire secondary sub-mixer - the monitoring mixer - to achieve the mixes necessary. This is the principle behind so-called 'split' consoles, with one section completely dedicated to recording to multitrack (the input section) and split from the other (the one dedicated to the group output/monitoring input facilities and mixdown to stereo).

These are the lines along which large recording desks first evolved. Channel, group/monitor and master sections were all in different modules. As music recording progressed from four track (in the Sixties) up through eight, sixteen and twenty four tracks, still there remained a requirement for each track return to have all of the controls listed previously and more besides. As the number of tracks increased, so the number of different foldback mixes needed to allow the musicians to keep track of what was going on during the recording session multiplied. What was present for most of the session on the stereo bus, except during mixdown, bore no resemblance at all to the finished mix. The provision of many different foldback mixes was one of the measures necessary to ensure that the artist was fed with what he/she needed at any particular point during the session. The effect on the size of the desk, when one considers a 24 bus example, needs little imagination - two mammoth mixers side by side, a recording one (say 56 inputs) and a monitor one (24 groups/ monitors), split only by the master module. All of the separate facilities of each were considered never to be needed simultaneously.

The amount of redundancy of console electronics at any one stage in the recording process was growing at a rate commensurate with the number of tracks involved. Desks of this immensity became not only an economic nightmare, but an ergonomic nightmare into the bargain. During a session, engineers were constantly to-ing and fro-ing, on wheeled seats, across the wide expanse of the desk in an effort to reach the farmost controls.

It's a Wrap(around)

A partial compromise (an expensive compromise) was in the adoption of the 'wrap-around' style of console. This type found vogue in the early Seventies until, later in that same decade, the width increased again. Despite rumours to the contrary, it was because of a growth in the number of input channels (which increased the central width) and not in an effort to accommodate the engineer's flared trousers! Nevertheless, and in spite of the punitive cost of such a design, it was a good arrangement. Costs were prohibitive, though, because each desk was in essence a one-off, custom job. See Figure 2.

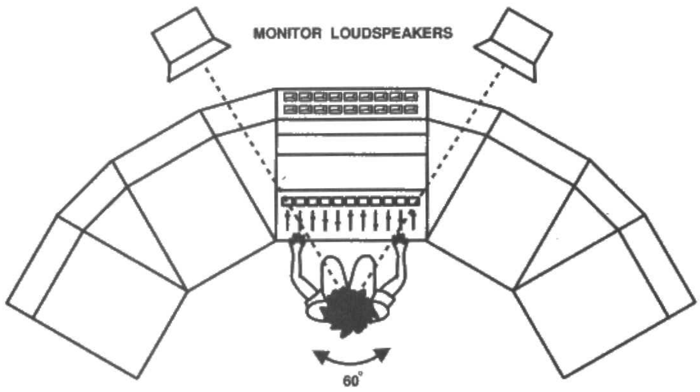


Fig.2 Wrap around style console

Eureka?

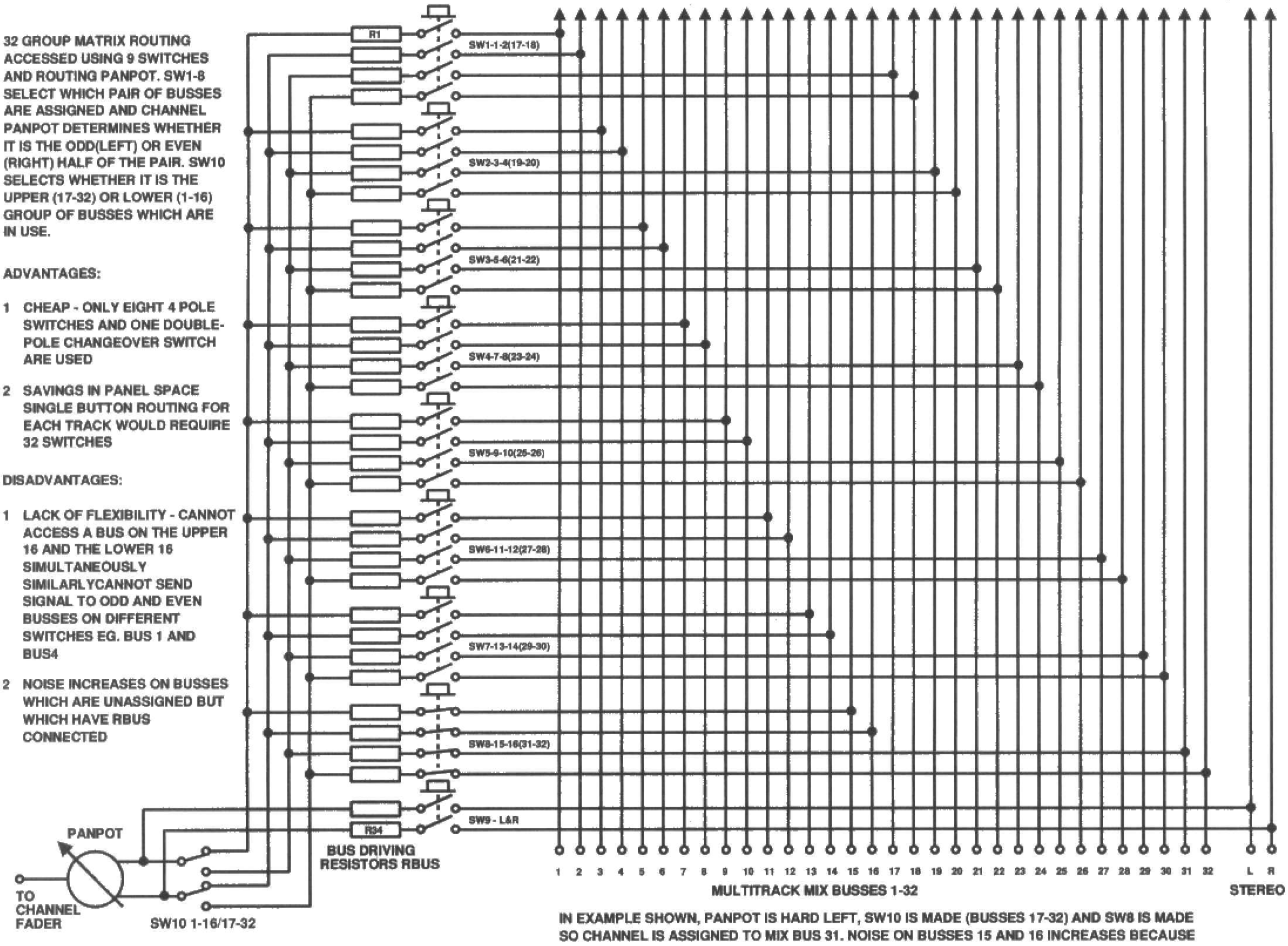
To sidestep such problems, the designers of the era needed to take a tangential look at the mixer and do some rather lateral thinking.

We've already said that just about every aspect of the monitor mixer is identical to that of the input mixer. It was a natural process of evolution to combine them in a multipurpose, input/output channel which could then be configured for whichever job it was being asked to do at a given time. Realising that both input and group/outputs could be combined in a single module - since the full facilities of each section would never be needed simultaneously - was a major step forward in the recording world since all recording/ mixdown requirements could be fulfilled in one multitask module.

It proved to be a somewhat radical, but nevertheless successful marrying of input and monitoring electronics. Understandably, however, there was more than a little reticence shown by many engineers to using a system which deviated so wildly from the conventional format and today, both types of desks find their proponents and detractors.

A further benefit, both from an operational and from a manufacturing point of view, was that some of the more superfluous parts of the split architecture - the group faders, for example - could be eliminated entirely from the new design.

So, the in-line console was born. Very quickly, other operational advantages were exploited. Facilities once available, on the input channel alone could now be arranged to



32 GROUP MATRIX ROUTING ACCESSED USING 9 SWITCHES AND ROUTING PANPOT. SW1-8 SELECT WHICH PAIR OF BUSSES ARE ASSIGNED AND CHANNEL PANPOT DETERMINES WHETHER IT IS THE ODD(LEFT) OR EVEN (RIGHT) HALF OF THE PAIR. SW10 SELECTS WHETHER IT IS THE UPPER (17-32) OR LOWER (1-16) GROUP OF BUSSES WHICH ARE IN USE.

ADVANTAGES:

1 CHEAP - ONLY EIGHT 4 POLE SWITCHES AND ONE DOUBLE-POLE CHANGEOVER SWITCH ARE USED

2 SAVINGS IN PANEL SPACE SINGLE BUTTON ROUTING FOR EACH TRACK WOULD REQUIRE 32 SWITCHES

DISADVANTAGES:

1 LACK OF FLEXIBILITY - CANNOT ACCESS A BUS ON THE UPPER 16 AND THE LOWER 16 SIMULTANEOUSLY SIMILARLYCANNOT SEND SIGNAL TO ODD AND EVEN BUSSES ON DIFFERENT SWITCHES EG. BUS 1 AND BUS4

2 NOISE INCREASES ON BUSSES WHICH ARE UNASSIGNED BUT WHICH HAVE RBUS CONNECTED

IN EXAMPLE SHOWN, PANPOT IS HARD LEFT, SW10 IS MADE (BUSSES 17-32) AND SW8 IS MADE SO CHANNEL IS ASSIGNED TO MIX BUS 31. NOISE ON BUSSES 15 AND 16 INCREASES BECAUSE R29 AND R30 ARE CONNECTED TO BUS

Fig.3a Group routing matrix example (32 bus example - limited access)

appear in either of the two parallel signal paths evident in this architecture. Normally, 'Flip' or 'Master' push buttons local to sections expedite this exchange of facilities between channel and monitor signal paths with, perhaps, a 'Master Channel Flip" control that effects rerouting of all signal paths within the module. There may also be a 'Console Flip' push-button (located on the master module) which can configure signal paths in each channel across the desk (although local Channel Flip controls can reconfigure individual channels as desired). Figure 4 in the June issue of ETI is representative and, rather than 'Channel Flip' type controls, the diagram shows multiway 'Mode' switches at strategic points throughout the channel electronics. These will be commanded by the automation system which resides in the Master module, although some, as in the example mentioned above, can in certain circumstances be overridden locally (on the channel strip). Other switches annotated with an asterisk will also normally be plumbed into the console automation system. Interlocks exist in certain modes and between certain switches to stop non-sensical routing arrangements from causing havoc with the console audio pathways.

The only downpoint, ergonomically and consequently, in the operation of the in-line design, was the required increase in channel module length, as a result of having to accommodate on each channel the increased number of switches and push buttons inherent in an in-line topology. This extreme length has meant adopting the practise of arranging that the most infrequently-used controls are sited at the top. To this end, channel input gain, phase reverse switching and phantom power switching controls, which are infrequently changed, normally reside in these murky recesses of the channel strip. In most normal circumstances, this is a minor irritation and a small price to pay for the overall increased convenience which in-line consoles afford the user.

Nevertheless, at least one major manufacturer, at the pinnacle of the pro-audio profession, considers that there is a lot of redundant circuitry in the In-Line type. Designers of these desks hold the belief that it is rare, except during overdubbing, for the module functions to be operated simultaneously and so cutting the signal path number from two, back to one, means making a single path of high quality more affordable. Their philosophy is to integrate the best features of the in-line architecture - comprehensive logic systems and master switching - into a 'split' format. The desk features a wraparound-style of design and is very expensive, but it may be a new answer to a familiar problem.

The Recording Process

In previous paragraphs, the words mixdown, overdubbing and recording have been bandied about freely. To fully understand what might reasonably be expected of a decent mixer routing system, we must first look at each of the steps involved in going from the original recording session, via multitrack, to the final stereo master. Only in this way will it become apparent just what a decent routing system must accomplish.

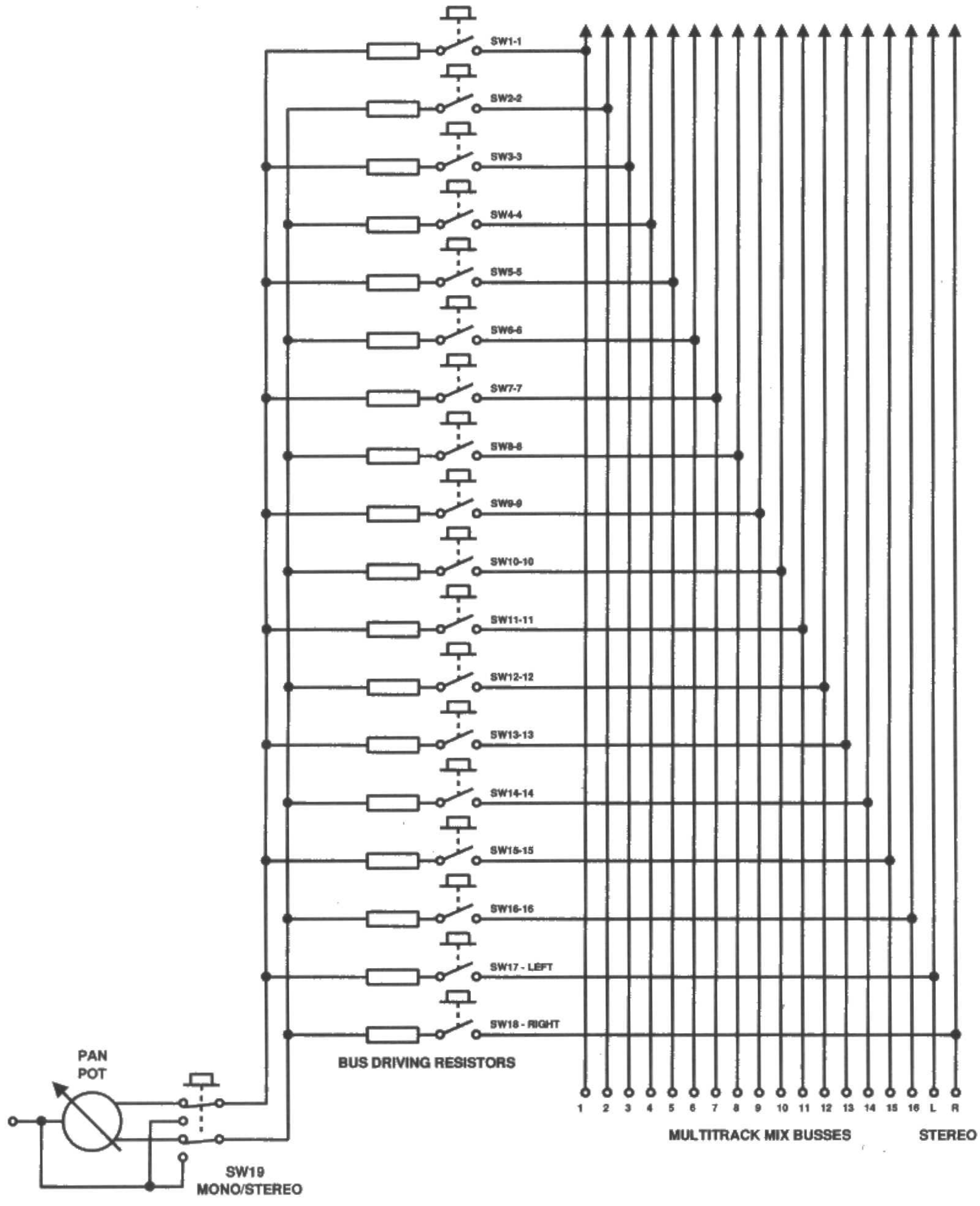
We will now look at the ways in which each of the two types (in-line and split) achieve the audio routing required at each of the different steps involved in the recording process. Where appropriate, in the description of each of the stages, I'll outline the differences which exist in the way that the audio is processed. Each of the main sections of Figures 1 and 4 from the June issue are represented schematically as boxes.

Recording

The name of the game during the recording step is to get the signal from the vocalist or musician, via a microphone and mic input (or the line input, in the case of an instrument) onto a given track of the multitrack. The only modules where mic amps are fitted are the input modules so any mic'd source must be applied to these. Little manipulation of the sound is done at this point, since the idea is to capture the sound just as it is - once it's safely on tape, it's an entirely different matter. The exception to the no-processing rule is in the use of noise gates, compressors or filters, which are used to tighten up the sound for recording, or to improve the overall clarity or fidelity of it.

The channel fader controls the input signal level to the bus, while the channel panpot sets its position in the stereo field. In-line architectures contain both channel and monitor faders (large fader and small fader) and channel and monitor panpots, hence the distinction. After the panpot comes the multitrack group routing matrix (and the post-fade take-offs for the post-fade Aux Mixes). This is a matrix of push buttons, either momentary if controlling solid state switches or latching if the mechanical switch itself is doing the routing of the audio.

With an eight bus system we need to be able to access each



16 GROUP MATRIX ROUTING ACCESSED USING 17 SWITCHES AND/OR ROUTING PANPOT. SW1-16 SELECT THE RELEVENT BUS (ODD=LEFT, EVEN=RIGHT)AND SW19 DETERMINES WHETHER THE SIGNAL IS DERIVED POST-PANPOT (AND FOLLOWS IT), AND SO IS STEREO OR IF IT IS DERIVED PRE-PANPOT AND IS MONO.

ADVANTAGES:

1 VERY FLEXIBLE - ALL BUSSES ARE ABLE TO BE ACCESSED INDIVIDUALLY OR COLLECTIVELY, NO MATTER WHETHER THEY'RE ON ADJACENT BUSSES OR NOT (EG. 5 & 6, 11 & 12). MATRIX INPUT SIGNAL CAN BE MONO OR STEREO.

DISADVANTAGES:

1 EXPENSIVE - 16 SINGLE POLE SWITCHES REQUIRED EVEN FOR A MEDIUM SIZED 16 BUS EXAMPLE.

2 PUSHBUTTON MATRIX OCCUPIES A LARGE AREA OF FRONT PANEL SPACE, SO BUTTONS MUST BE MADE SMALL IN ORDER THAT SPACE USAGE BE MAXIMISED.

3 DIFFICULTY IN AUTOMATING AN ARRANGEMENT SUCH AS THIS - REQUIRES TWO EIGHT BIT WORDS TO DETERMINE ON/OFF STATUS OF EACH GROUP.

3b Group routing matrix example (16 bus system, all busses able to be assigned singly)

16 GROUP MATRIX ACCESSED USING ONE DOUBLE-POLE 8-WAY ROTARY SWITCH

ADVANTAGES:

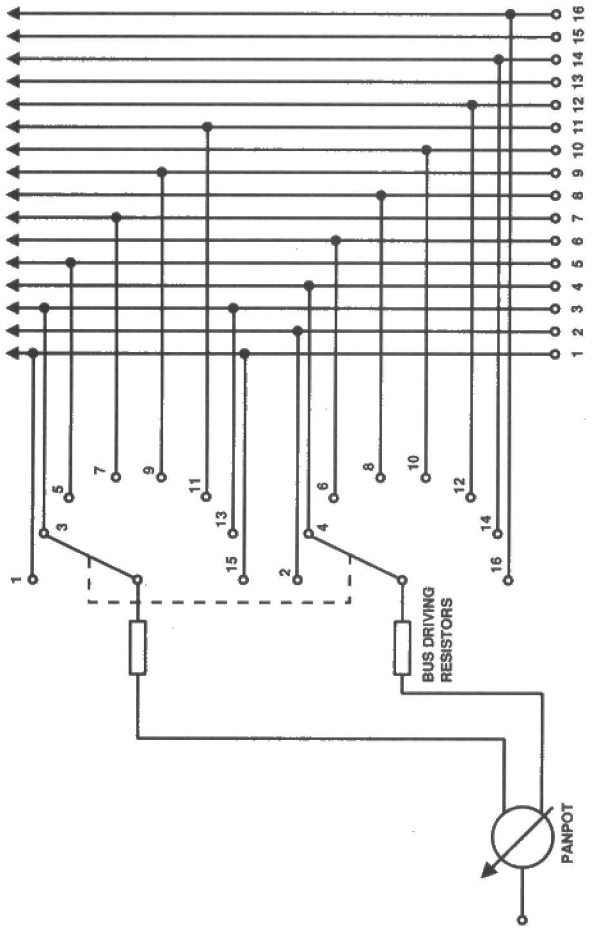
1 CHEAP AND CHEERFUL - ONLY ONE SWITCH AND ONE PAIR OF BUS DRIVING RESISTORS IS REQUIRED.

2 VAST SAVINGS IN PANEL SPACE - ONLY ONE ROTARY SWITCH REQUIRED. A 4 BUS, 8 BUS, OR 32 BUS ROUTING SWITCH OCCUPIES THE SAME FRONT PANEL AREA. OFTEN USED ON BROADCAST DESKS WHERE SUCH A SIMPLE SYSTEM AND THE SMALL NUMBER OF GROUPS REQUIRED LENDS ITSELF READILY TO EASY OPERATION. RECORD DECKS (GRAMS), MICS, OUTSIDE SOURCES (OS) ARE ALL ALLOCATED THEIR OWN GROUPS SO THAT ONE GROUP FADER ACTS AS A GRAND MASTER FOR ALL SOURCES (BE THEY GRAMS, MICS OR WHATEVER) WITHIN THAT GROUP.

3 EASY TO AUTOMATE - 8 AND 16 WAY MULTIPLEXERS ARE COMMONPLACE AND INEXPENSIVE AND ORDINARY BINARY ADDRESSING OF SUCH SWITCHES MAKE THEM VERY SUITABLE FOR INCLUSION INTO A BUS-ORIENTED SYSTEM.

DISADVANTAGES:

1 ONLY ONE PAIR OF BUSSES ARE ABLE TO BE ACCESSED AT ANY ONE TIME. THIS CAN BE VERY LIMITING FROM THE POINT OF VIEW OF FLEXIBILITY AND IS A MAJOR DISADVANTAGE IN A RECORDING DESK.



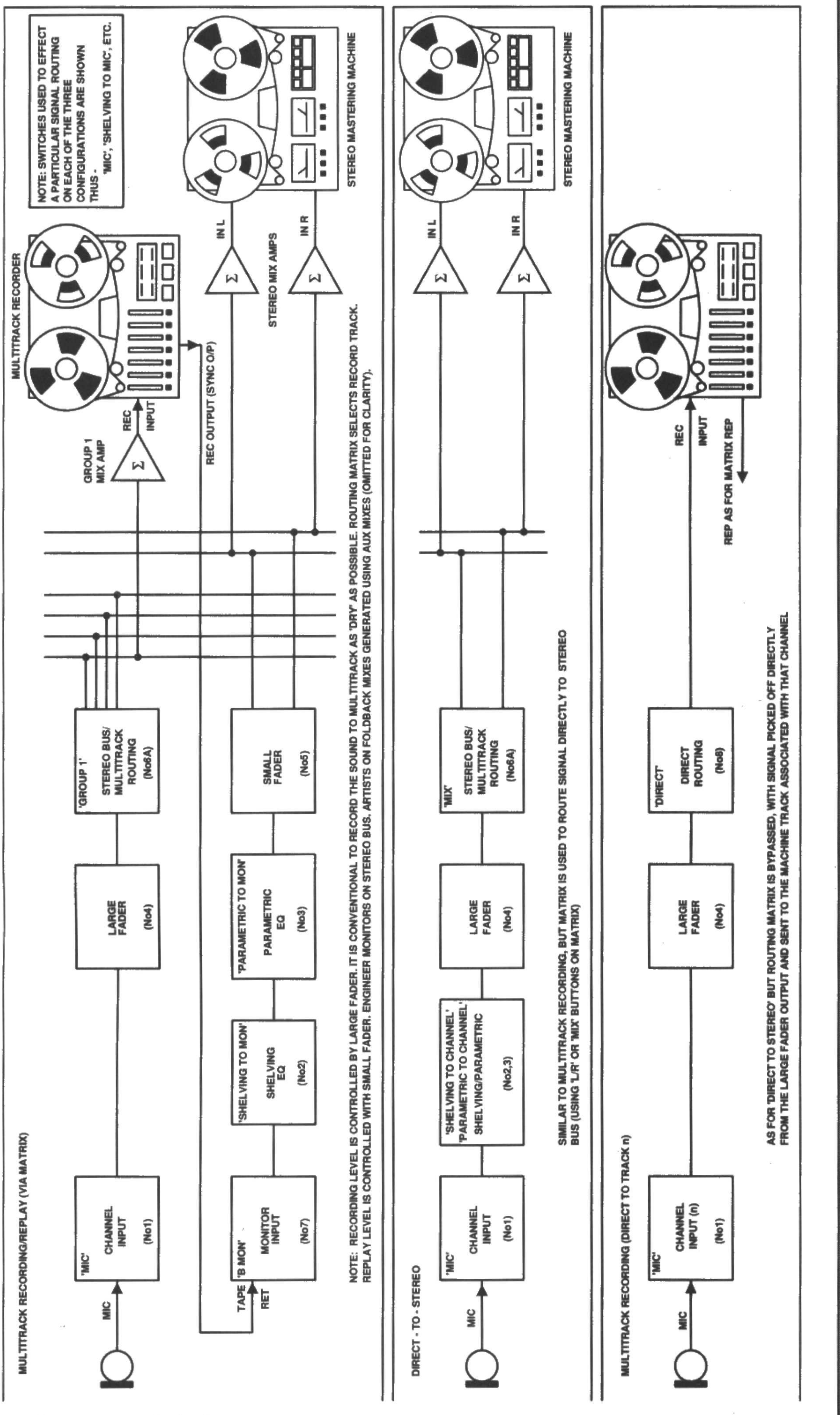
3c Group routing matrix example (16 bus system, only one pair of busses able to be accessed)

of the eight busses individually.

Depending on the manufacturer, a typical eight bus example might use only four push buttons, each accessing two adjacent busses, i.e. 1 and 2, 3 and 4, etc.. Normal studio convention is for the odd-numbered busses to be left and the even-numbered to be right. Accessing a bus singly may be done by using the pan-pot; to access group 4, say, the 3/4 button is pushed and the pan-pot routed hard right. Other systems use an odd/evens push-button in conjunction with the bus switches to achieve the same effect, while some use eight individual push buttons. Up to about 16 groups, a similar principle is applied. Above this, the number of push buttons necessary to access groups either individually or in pairs becomes cumbersome and another push-button, similar in operation to the odds/evens one, accesses the upper or lower 16 groups, say, of a 32 group matrix. It is normal also to fit a Stereo or Mix push-button to the matrix, this being used to route to the main stereo mix bus. Figures 3a, b and c are representative of just about all of the routing systems currently in operation in small to medium-sized consoles. It is of interest to note that invariably, broadcasters go for a much simplified version of 3c, with perhaps only two or three groups assigned via one rotary or three position switch. Tapes, Grams (turntables) and Mics occupy their own groups, so that the faders associated with individual programme sources are invariably set and then left alone. An operator will cue up a tape or a record and the presenter then need only open the group fader associated with that kind of source. In this way, he or she need not worry what machine of the three or four in the cubicle the material is being played upon, all that is required to play a tape on air is for the presenter to open the Tape group fader.

Back in the recording environment, a signal, once routed on to a particular bus (which may be carrying further input channels), is outputted via a mix amp (and a group fader on a split console) to one track of the multitrack tape. Because there are no individual group modules in an In-Line desk, each input/output channel is wired to pick a particular group mix bus off the matrix, so that channel one would also carry the bus signal outputted as group 1, channel 2 would carry group 2 and so on and so forth.

In-line consoles (and some split ones, too) cater for another audio route to the tape track. It is known as Direct and allows direct routing from the output of the channel fader to the bus output jack associated with that particular input channel. As an example, pressing Direct on Channel 1 would send channel 1 directly to bus 1 output, pressing it on channel 7 would send it directly to bus 7 output jack and so on. In this way, the unnecessary stages of routing, amplification and the process of mixing onto a bus can be avoided, thus improving on the noise performance of a particular track requiring only one source recorded on it. Another Direct function sometimes incorporated into the channel is Direct to Stereo, where all of the inputs can be mixed straight down on to the stereo bus, again avoiding unnecessary use of - and possible degradation because of - the group routing matrix. Some consoles incorporate a feature known as Bounce or Free Grouping into the track routing matrix, which extends the flexibility when using a smaller machine such as an eight track, and we'll explore this as a separate issue. Others incorporate the Direct function as a default, with a button having to be depressed to disable it.



NOTE: SWITCHES USED TO EFFECT A PARTICULAR SIGNAL ROUTING ON EACH OF THE THREE CONFIGURATIONS ARE SHOWN THUS - 'MIC', 'SHELVING TO MIC', ETC.

NOTE: RECORDING LEVEL IS CONTROLLED BY LARGE FADER. IT IS CONVENTIONAL TO RECORD THE SOUND TO MULTITRACK AS 'DRY' AS POSSIBLE. ROUTING MATRIX SELECTS RECORD TRACK. REPLAY LEVEL IS CONTROLLED WITH SMALL FADER. ENGINEER MONITORS ON STEREO BUS. ARTISTS ON FOLDBACK MIXES GENERATED USING AUX MIXES (OMITTED FOR CLARITY).

SIMILAR TO MULTITRACK RECORDING, BUT MATRIX IS USED TO ROUTE SIGNAL DIRECTLY TO STEREO BUS (USING 'L/R' OR 'MIX' BUTTONS ON MATRIX)

AS FOR 'DIRECT TO STEREO' BUT ROUTING MATRIX IS BYPASSED, WITH SIGNAL PICKED OFF DIRECTLY FROM THE LARGE FADER OUTPUT AND SENT TO THE MACHINE TRACK ASSOCIATED WITH THAT CHANNEL

Fig.4 In line and split methods of recording

This track laying process is repeated along each of the individual tracks until each is recorded upon. As the mix progresses and more and more tracks of the tape become occupied, it becomes increasingly important that the person providing the contribution at any time during the mix can hear what has already been recorded on tape. It is normal for the drum sound and balance to be done first since the drummer is recorded in an isolation booth and the other musicians normally like to have something to listen to as they play. Next comes bass and electric guitar, keyboards, vocals, etc..

This is where the monitor sections come in. On a split console, the tape returns (from the machine repro heads) are situated on the monitor sections and normalled through to the individual channel line inputs or separate B-check machine inputs. Each monitor section can source what is going out on the Group bus associated with that particular section or track (A-check or Source) or coming back from the tape track (B-check or Tape). All but the least expensive machines are clever enough to know what any particular track is doing at any one time - recording or replaying - so this switch is often left permanently connected to Tape and the machine left to control source/tape switching. As mentioned earlier, some mixers do away with such a switch completely and let the machine do any switching that is necessary.

Associated with each of the monitor sections, as already discussed, is a level control, simple EQ section, pan-pot, and level and routing controls allowing access to each of the Aux Mix busses. These are then used to generate the individual foldback mixes necessary for each of the different musicians. Obviously, different musicians playing different instruments might have different foldback requirements, so access to a large number of such foldback mixes is advantageous operationally.

An in-line console does things somewhat differently. The off-tape signal is routed back to its associated input/output channel via the Tape Return jack. All of the facilities of this channel - noise gates, filters, EQ, large channel fader, etc. - and any other channel dealing with an off-tape signal, are flipped to monitor so that for the monitor signal, the engineer has at his/her disposal all of the facilities and flexibility normal available only to input (channel) signals during recording.

Figures 4 shows the main elements of input and monitoring facilities as blocks. These can be cross-referenced to corresponding dashed and numbered sections of the in-line and split schematics of Figures 1 and 4 in the June issue. In this way, it is much easier to follow signal routing in the different modes of operation and to see what part they play in each. Such a simplified approach allows the operation of any desk, no matter how complicated, to be easily understood.

Next month, we continue to look at audio pathways during Mixdown, Overdubbing and sub-grouping before looking at the switching involved in the Automate's Aux mix busses.

References

Dove, Steve, Consoles and Systems, The Audio Cyclopedia (edited by Glen M. Ballou), SAMS

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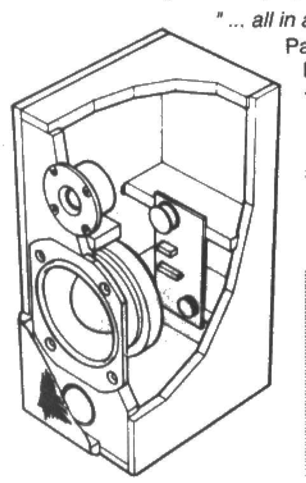

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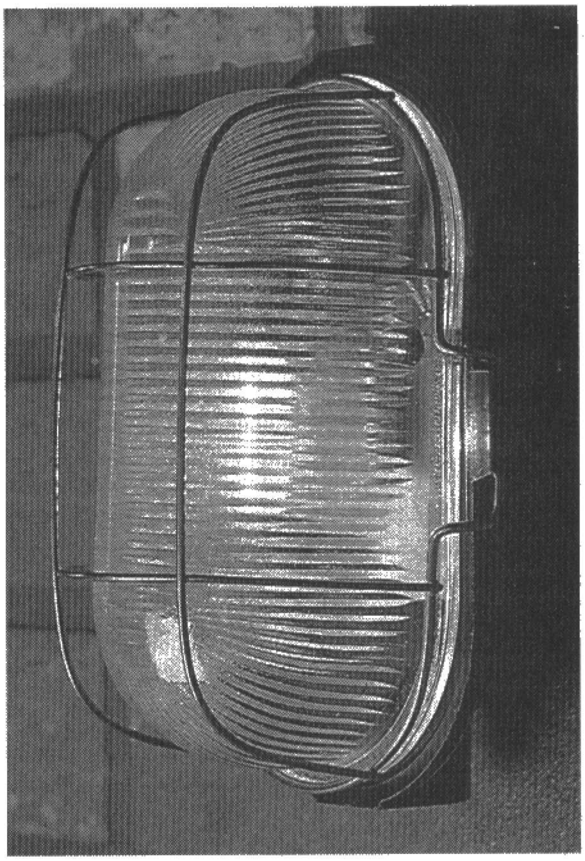
ETI Cover PCB Project

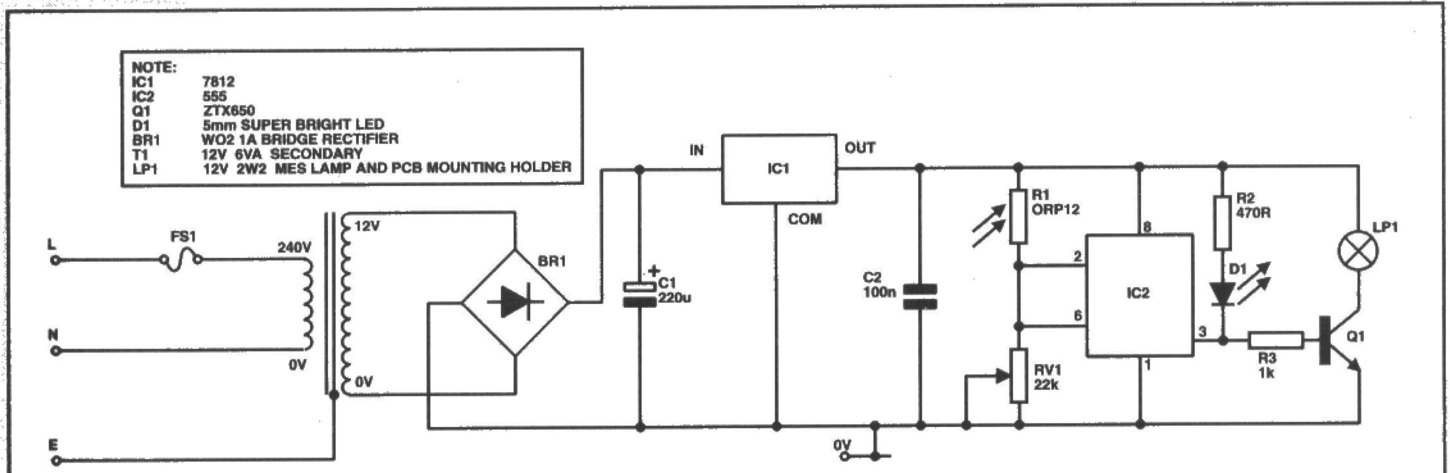
A light which comes on automatically at dusk and switches itself off at dawn, all without user intervention, has many applications. The Twi-Light was originally designed to provide all night low-level illumination of the author's otherwise unlit garden path.

Conventional outside lamps, the majority of which use mains bulbs of 60W or greater, would prove quite expensive to use for regular all night illumination. Taking an average usage of 12 hours per night over a period of one year, a 60W lamp will use roughly 250 units of electricity. With current electricity costs of around 7.5 pence per unit, at standard rate, the annual running cost would be nearly twenty pounds.

The cost of running the 2.2W bulb used in the prototype unit is around one pound per year - barely significant. Thus the cost of constructing the unit could be recovered in less than twelve months.

A mains power supply is not essential for the Twi-Light, so it may easily be adapted for use as an automatic outside lamp for a caravan, which on some of the caravan sites frequented by the author would not be regarded as a luxury!





NOTE:	
IC1	7812
IC2	555
Q1	ZTX650
D1	5mm SUPER BRIGHT LED
BR1	WO2 1A BRIDGE RECTIFIER
T1	12V 6VA SECONDARY
LP1	12V 2W2 MES LAMP AND PCB MOUNTING HOLDER

Fig.1 Circuit of Twi-light

Light Sensing

Electronic sensing of light levels is not difficult and there are many suitable transducers on the market, most of which are inexpensive.

The cadmium sulphide (CdS) light dependent resistor (LDR) is one of the best known devices available, particularly as the ever popular ORP-12. It is also amongst the least expensive and is probably the easiest to use, with its linear luminance/resistance characteristic and its wide variation of resistance with light level.

Circuit Description

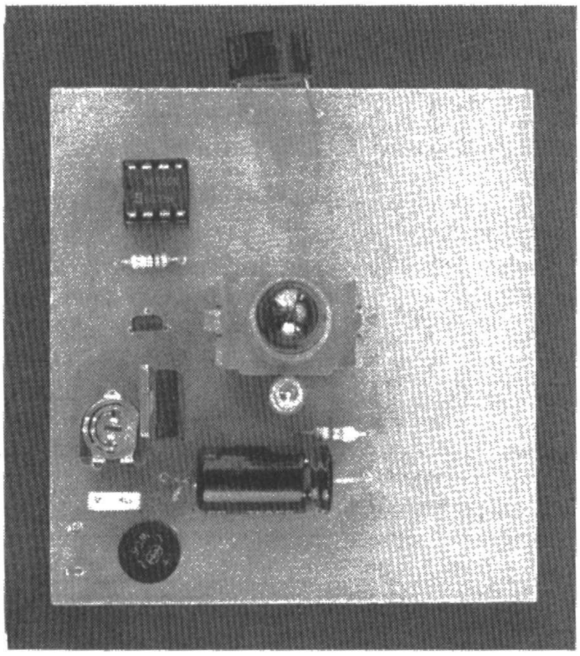
The complete schematic for the mains powered version of the Twi-Light is provided in Figure 1. A suitable mains power supply is also included in this circuit diagram, but if operation from a car battery is envisaged, the power supply section may be omitted. Complete details of this modification are provided later.

The mains power supply section, comprising transformer T1, bridge rectifier BR1, smoothing capacitor C1 and monolithic voltage regulator IC1 provide regulated 12V DC for the electronics and the lamp.

The light dependent resistor R1 and a preset potentiometer RV1 are connected across the 12V, supply forming a potential divider network. The output voltage of the potential divider varies with illumination level and is sensed by the flip-flop in a 555 timer, IC2.

This device normally senses the voltage level on a timing capacitor, which is omitted here, the output going high when pin 2 (the Trigger input) is taken to a voltage level of less than 1/3 of the supply voltage. The output returns to the low state when pin 6 (the Threshold input) is taken higher than 2/3 of the supply voltage.

The difference in the voltage levels required for the output to switch from the high to low states and vice-versa is very important in this application as it provides the necessary hysteresis for correct operation. Without this hysteresis, the output would fluctuate between the on and off states as the lamp was switched on and the photocell being illuminated by the lamp would experience a fall in resistance, thus turning the lamp off again. This would repeat cyclically until the ambient light level fell sufficiently for the combined effect of daylight and the light from the lamp to be insufficient for repeated triggering.



The output of IC2, at pin 3, is only capable of driving small loads and is followed by a single stage of transistor amplification, comprising Q1 and resistor, R3 to limit the current into its base. The device specified for Q1 is capable of handling currents of up to 2A and will comfortably drive a 10W (maximum) bulb at 12V.

An LED, D1, connected between pin 3 of IC2 and the positive supply rail via current limiting resistor R2, switches on during daylight hours to indicate that the circuit is powered and functioning. In darkness, when the lamp illuminates, the LED is extinguished.

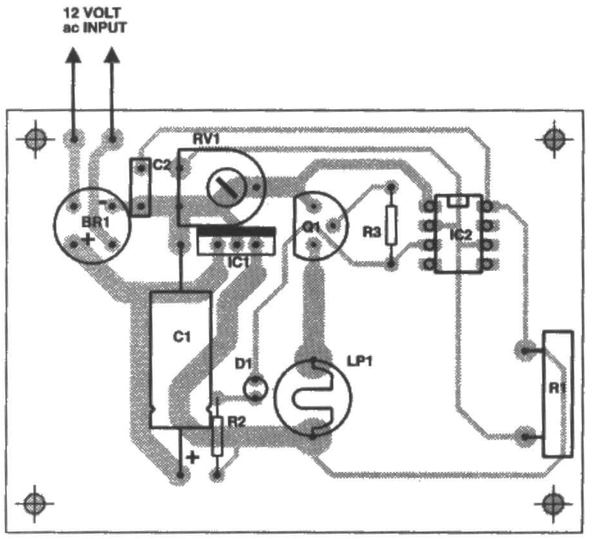


Fig.2 Component Overlay

PCB Construction

A suitable PCB foil pattern and component overlay for the Twi-Light are provided in Figure 2. The heavy tracks on the board have been designed to handle the current required by a 10W lamp, so if an alternative layout is envisaged this should be borne in mind.

The order of assembly of components to the PCB is not particularly critical, though fitting the smaller components first would be sensible. Take care with the semiconductors, as they are easily damaged by the application of excessive heat. The orientation of these devices is also critical and particular care should be taken with the bridge rectifier, BR1. A socket is recommended for IC2 and will alleviate any problems which may occur with this device.

The LDR, which is mounted at one end of the PCB, should be angled to face away from the main bulb and any external light source (other than the sky) to avoid unwanted triggering.

The Twi-Light, as originally designed, was intended for use with a 2.2W, 12V MES lamp and no heatsinks were fitted to IC1 or Q1. With a larger lamp, heatsinking will be necessary for both of these devices. IC1 may be fitted with a readily available TO-220 clip on device. A commercial heatsink for the small 'E-line' packaged power transistor, Q1 may prove difficult to locate and a small piece of thin aluminium super-glued to the device after it has been soldered should prove adequate.

Bulkhead Lamp Modifications

The prototype Twi-Light was housed in a standard 240V, 60W weatherproof bulkhead lamp assembly and any similar unit, of suitable dimensions, may be employed for outdoor use.

The original lampholder and reflector assembly should be removed from the fitting and discarded (or put in the junk box for future use). Knock one of the cable entry holes through in the fitting and assemble the supplied cable gland to it. Use round double insulated mains cable for the 12V feed to the unit, increasing its diameter with PTFE thread tape as necessary, to form a water-tight seal when the gland is tightened onto it.

If the mains version is being built, connect the cable to the DC input pins on the PCB, the polarity being unimportant.

For the 12V version see Modifications.

The printed circuit board as shown is the correct size to fit the most popular type of bulkhead lamp and is held in place by the glass diffuser and rubber seal supplied with the original unit. If another type of unit is used, it may be necessary to fix the board in place with double sided self-adhesive pads. The use of any fixings which necessitate the drilling of holes in the lamp fitting is not to be recommended, as this could lead to the ingress of moisture.

When mounting the completed unit outside, the cable should enter the unit at the bottom and the LDR should, ideally, point towards the sky.

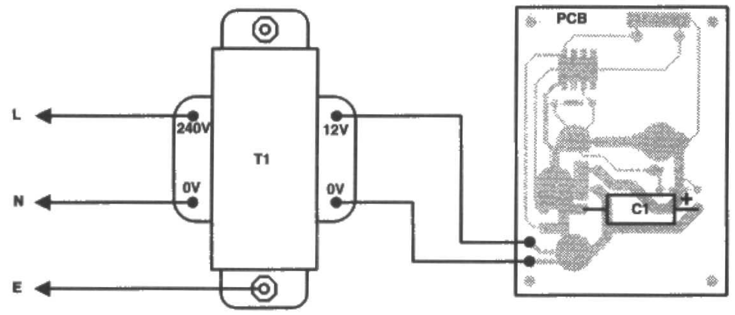


Fig.3 Transformer wiring diagram

Mains Power Supply

If the Twi-Light is to be mains powered then a suitable transformer will be required. The transformer needs to have a 12V secondary with a VA rating of at least twice the power of the lamp, e.g. a 10W lamp will need a 20VA transformer.

The transformer should be fitted in a ventilated enclosure and mounted remotely from the lamp. Figure 3 shows the wiring details. The mains plug should be fitted with a 3A fuse and the transformer must be earthed.

Setting Up

Set the preset, RV1 to its mid-position, apply power and cover the LDR with your hand. The lamp should light immediately. If not, try adjusting RV1 until it does.

Fit the lamp in its final installed position and, at dusk, adjust the preset until the lamp just comes on. Fitting the glass may have an effect on the triggering point, thus requiring adjustment over a period of a few days until the optimum trigger point is obtained.

Fault Finding

The circuit is very simple and fault finding should be quite straight forward. Before suspecting component failure, look for obvious faults such as solder splashes, semiconductors inserted the wrong way round (particularly BR1), etc.. The use of an IC socket for IC2 may well be appreciated at this stage, since it may be readily checked by substitution with a known working device. Check the supply voltage to IC2, as this device will withstand a maximum of 15V and requires a minimum of 3V to work. In this application, 12V is required for the bulb.

Modifications

For operation from a 12V car battery (for use with a caravan, etc.) the PCB layout given in Figure. 4 should be used. All component values are as per the mains version and are given in the components list. The LED has been retained as its current consumption is so small as to be insignificant, but it may be omitted if desired.

It is very important to note the new positions for the 12V supply connections and also that the polarity is now of vital importance for the survival of the semiconductors. An in-line fuse, fitted in the positive supply lead as shown, will give protection against overload or short circuits.

For a child's night-light, the PCB may be trimmed down and installed in a plug in power supply box. A tinted filter securely fitted over a cut-out in the box lid will provide a gentle glow to chase away the shadows. The LDR should be mounted on the outside of the case with its leads fed through suitable holes to their respective connections on the board.

Particular attention should be paid to safety if the Twi-Light is to be used in a child's room, especially with regard to the choice of enclosure. Make sure that the plug-in case has shrouded live and neutral pins.

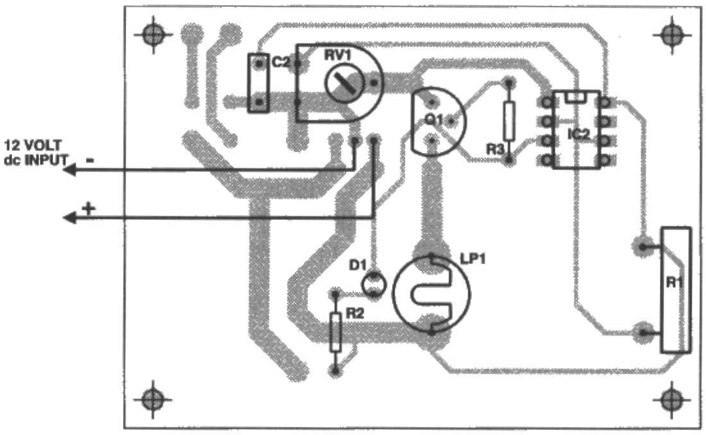


Fig.4 Component overlay of 12V version

PARTS LIST

RESISTORS
R1 ORP12
R2 470R
R3 1k
RV1 22k Sub Min Horiz Preset

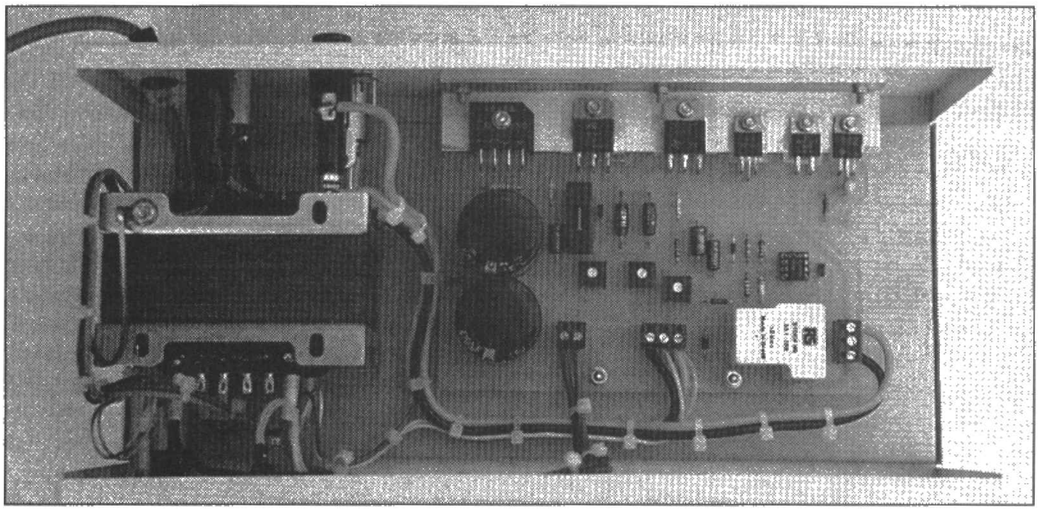
CAPACITORS
C1 220µ 25V Axial Electrolytic
C2 100n Polyester 5mm Pitch

SEMICONDUCTORS
BR1 WO2
D1 5mm Super Bright Red LED
Q1 ZTX650
IC1 7812
IC2 555

MISCELLANEOUS
T1 Mains Transformer 12V 6VA Secondary
LP1 12V 2.2W MES Lamp and PCB Mounting Holder
Bulkhead Lamp Fitting; PCB; 5A Round Mains Cable, 2 Core; Case to suit Mains Transformer

BUYLINES

The bulkhead lamp fitting was purchased from Wilkinsons.



Alternative 12V Supply

by K R Ginn

This power supply was originally designed to power a three port packet node. In this application, where a quiescent current of approximately 400mA per rig was needed, totalling some 1.2A on receive and about 15A with three rigs simultaneously transmitting. A 20A supply could have been designed and built to suit these needs, but I decided to adopt a different approach to the power supply problem. To understand the reason why, you have to consider the structure of current demand for a packet node.

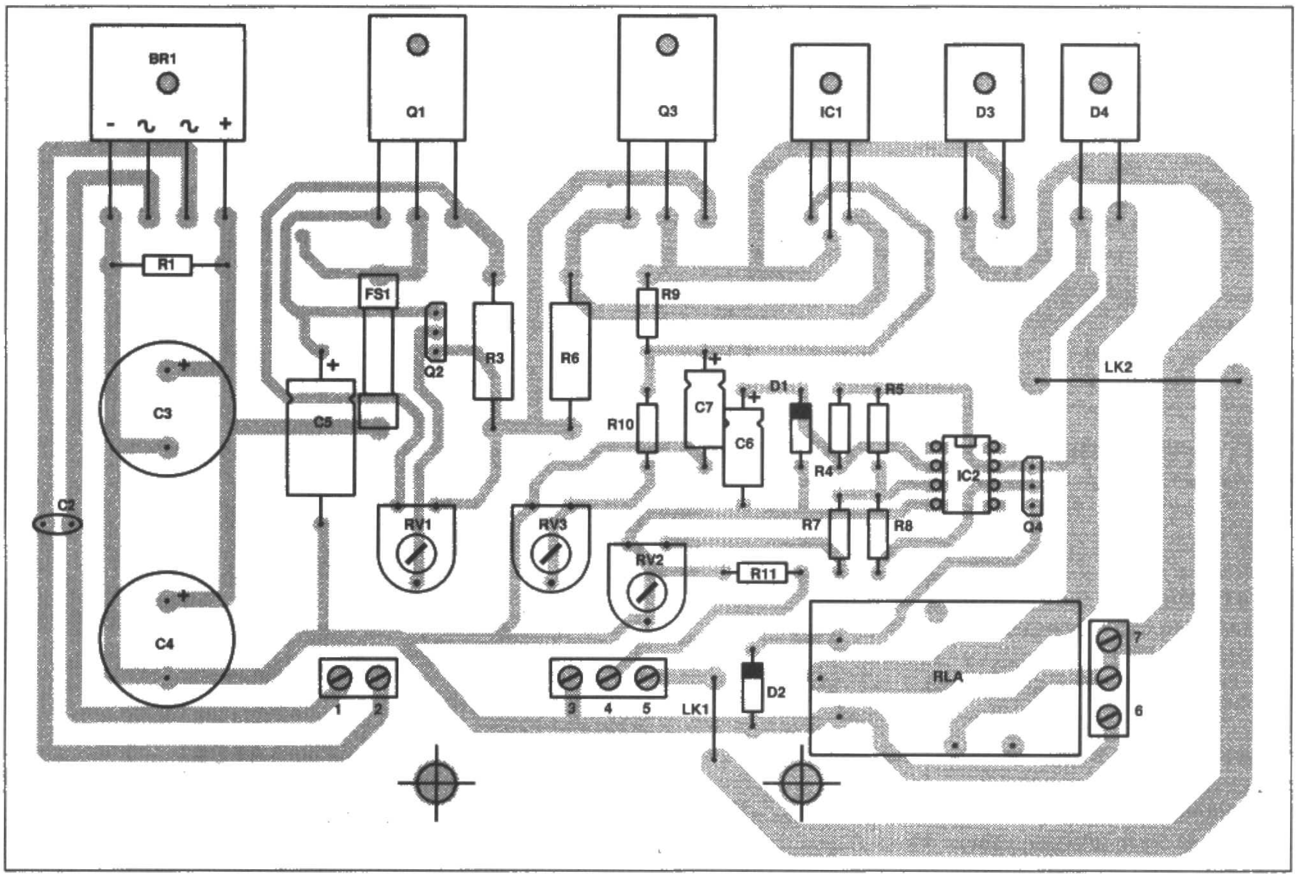


Fig.1 Component Overlay

Current Demand

In a packet system, the node (or Terminal Node Controller, TNC) is waiting and in a receive state for what could be 90% of its operational time, for the majority of nodes. The rest of the time it is, of course transmitting, from which we can see that there is quite a high duty cycle biased towards the receive. What was called for in this design was a power supply which would supply the quiescent current during the receive part of its duty cycle and only supply the additional higher current on demand, without building a full blown 20A supply. There may be times when all three rigs will be transmitting together, i.e. drawing maximum current from the supply, but this incidence is bound to be very low. The situation where two rigs are transmitting is more common and a peak current of 10A is the more likely of the two. Nevertheless, the PSU had to have the capability of supplying the full simultaneous transmit current of the three rigs.

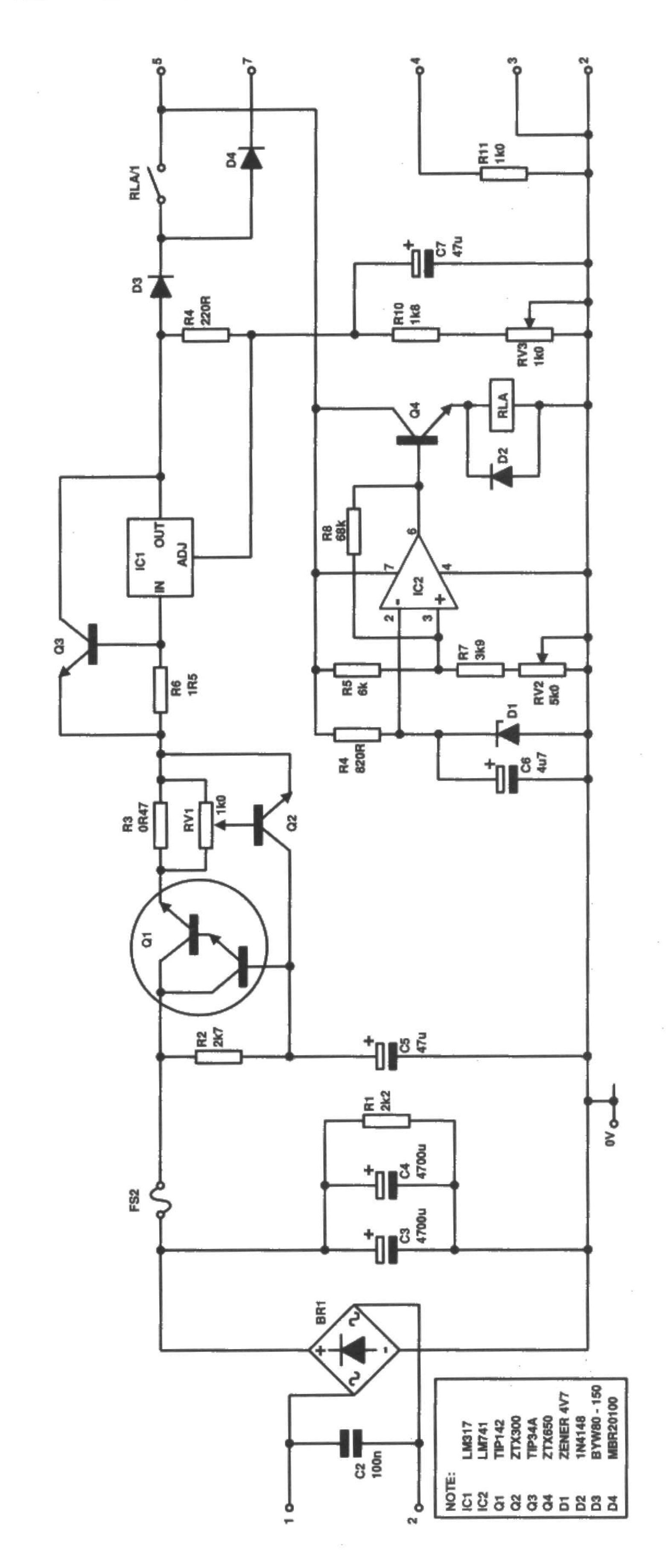
The supply I chose is basically a low current source, which will supply the receive current for the three rigs from the ac mains derived power source. The additional transmit current will come from a gel cell storage battery, which is float charged during receive times and is topped up during the transceiver's receive cycle.

Mains input stage

The AC mains is taken through a mains isolating transformer (T1), converting the voltage down to 15V rms ac, then rectified through the bridge rectifier and onto the smoothing capacitors (C3 and C4). At this point we will expect to see 23V dc. C1 and C2 serve to illuminate noise coming through the mains transformer, either mains born noise to the equipment or RF noise to the mains supply.

Current Limit Circuit

There follows a discrete current limit circuit, Q1, Q2, R2, R3, RV1 and C5, which limits the current drawn from the transformer to 3.0A and this will operate only when one or more rigs goes into transmit, or if the battery needs to take a high charge current, having been discharged. This circuit will limit the dc supply current drawn from the mains transformer secondary's rectified side to 3.0A DC (approximately 5.2A RMS AC) whose



NOTE:	
IC1	LM317
IC2	LM741
Q1	TIP142
Q2	ZTX300
Q3	TIP34A
Q4	ZTX650
D1	ZENER 4V7
D2	1N4148
D3	BYW80 - 150
D4	MBR20100

Fig.2 Circuit diagram

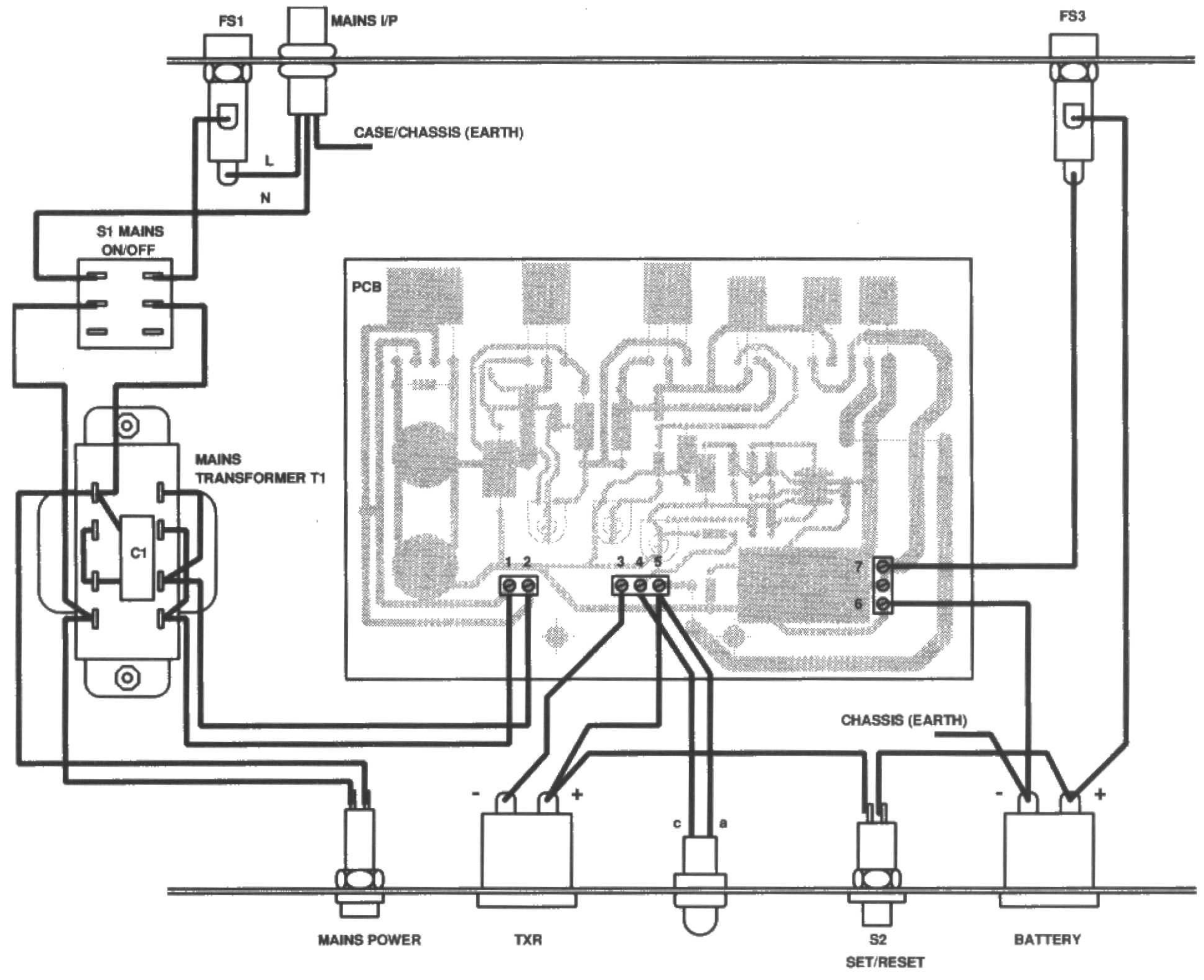


Fig.3 Interconnections

actual value is set with adjustment of RV1.

Normally, when the current drawn through this part of the circuit is less than 3.0A, the voltage across R3 and RV1 is less than 0.7V. With insufficient base-emitter voltage to turn on Q2, Q1 will be turned hard on through the base bias current supplied by R2. Therefore, the voltage drop across the current limit circuit will be minimal. When the current rises through R3 and the voltage across it in proportion, Q2 will begin to turn on, robbing Q1 of base drive current. This will have the effect of limiting the current through Q1 and R3.

C5 is included to give some degree of decoupling to Q1 and will reduce any mains ripple from the smoothing capacitors to a more acceptable level, i.e. 250mV peak-to-peak on the output of this part of the circuit.

The reason for adopting this approach to have a separate current limit circuit ahead of the voltage regulator, as opposed to one incorporated within a constant voltage source. If a standard power supply were used, for example a 723 IC regulator, you would find that when the power supply goes into current limit (during transmit or a period of heavy charging current demand) the error amplifier of the 723 regulator will fight against the current limit circuit to maintain a constant output voltage. In this situation, the power supply would oscillate at an amplitude dependent on the amount of current drawn, the greater the current drawn the greater the fall in output voltage and the greater the oscillation of the power supply's output voltage. This would inevitably amplitude modulate the dc supply to the transceiver and ultimately the RF power to the aerial.

A current limit condition in most power supplies is a fail condition of some sort, a failure of the load which has for some reason decided to draw more than the permitted current, whereas in this circuit it is not and is exploited.

Voltage Regulator Circuit

There follows a three terminal regulator with an extension to the basic configuration, which will increase the current through what is a 1.5A regulator. This, with the addition of R6 and Q3, will raise the current handling of this stage to above 4A, more than is actually needed for the supply. This stage sets the charging voltage for the gel cell battery. which can be set to between 14.4 and 15.0V, the recommended charging voltage for these types of battery.

Three terminal regulators are quite common - IC1 supplies the first 400mA of current and as the current rises through R6, Q3 will begin to turn on, thus causing current to flow through the emitter-collector of the transistor. Any additional current above 400mA will flow through Q3 and increase the current handling of the regulator circuit.

Safety Cut-out

Incorporated alongside is a safety cut-out circuit, which will isolate the battery from being over discharged in the event of a mains failure. It is a 741 op-amp configured as a comparator, with additional hysteresis of about 1V added. The purpose of the cut-out circuit is to monitor the battery's terminal voltage and, as long as the battery voltage remains above 11.5V (set with RV3) it will remain active within the system and will supply the additional transmit current required by the connected equipment. It ensures that the battery is not destroyed by too deep a discharge, which would otherwise cause irreparable damage.

When a supply of around 12V is applied to the circuit via the momentary push button switch S2, IC2's circuit becomes active. D1 is supplied with a current via R4 of 10mA and supplies a stabilised reference voltage to the comparator pin 2 of 4.7V. Pin 3 of IC2 picks off a portion of the voltage applied to this circuit, with the potential divider R5, R7 and RV2. R8 provides the hysteresis.

When the voltage applied to the circuit is higher than 11.5V, the voltage at pin 3 of IC2, when set correctly, will be a little greater than the 4.7V which is supplied by the zener diode as the reference to pin 2 of the same IC. The voltage on the output of IC2, that is, pin 6, will also be high in this condition (+12V) causing Q4 to conduct and turning RLA on, as the voltage is higher on the non-inverting input of IC2 than the inverting input. The voltage at pin 3 of IC2 will also be influenced by a secondary path to this input, as R8 is effectively in parallel with R5. When the voltage to the circuit drops below the trigger level, i.e. 4.7V at pin 3 of IC2, the output of IC2 will fall to 0V, thus turning off the relay RLA. R8 will now be effectively in parallel with R7 and RV2, causing the voltage at pin 3 IC2 to fall lower, further changing it's operating point.

When power is reinstated to this circuit, a greater potential has to be applied to it to overcome the hysteresis built in. This is simply effected by closing momentarily the contacts of S2.

The hysteresis is added for two reasons, one of which is that at the switching point of the comparator, the output will tend to oscillate and cause the relay RLA the buzz erratically. The second is to enable the battery, in the event of a mains failure, to be recharged successfully before it is connected back to the supply's load. The terminal voltage of the battery in a discharged state will be low, so this has to be raised sufficiently to give the battery time to be charged up before being discharged again. If this approach was not adopted with an additional mechanical reset, the battery would undoubtedly take a considerable time to reach a fully charged state.

As the mains supply (current limit) would be supplying current to the transceivers in both receive and transmit modes as well as the battery, the transmit output current of the supply would not be reached in this way with a discharged battery. Time is given for the battery to be charged again before the equipment is once again connected to the supply.

Construction

The whole unit can be built in one of two ways, either housing all the electronics, including the gel cell battery, within a common enclosure, or housing the battery remotely. The first approach was employed here, as this lends itself to a greater flexibility in the choice of batteries. The whole unit, including the battery, was to be housed within a home made enclosure, which would make the whole unit safe from prying hands and falling objects, which could be rather dangerous if they were to come into contact with the terminals of the battery, in particular.

The components are mainly accommodated on one PCB, as shown. The board is attached to the rear of the enclosure with a piece of aluminium angle which forms part of the heatsink and all the major power devices, which emit a reasonable amount of heat, are attached to this. This helps to keep the whole unit cool. An additional heatsink could be attached to the rear of the enclosure to aid in the cooling.

Wiring within the unit is made as short as possible, to avoid unnecessarily long runs which would induce a significant voltage drop along it's length. Those wires which are carrying any appreciable current will have to be able to cope with the running current, in this case 15A peak. 50/0.25 cable is rated at 30A continuous and will be adequate, but at a pinch 32/0.2 is also suitable, as the current rating for the power supply is not a continuous one and will not permit the wire to heat up to any appreciable degree.

Setting Up

The unit once fully assembled is ready for setting up and there are only three presets on the PCB, making it an easy task. Set all presets to their mid position.

RV1 sets the current limit to, in the prototype's case, 3.0A. This is accomplished by connecting a high power wirewound resistor or combination to make 3R3 ohms to the output of the supply, i.e. the transceiver socket, with an ammeter in series with the resistor. Adjust RV1 until the current reads 3.0A. The output voltage will fall slightly, by approximately 1V, to indicate that the circuit is working properly. Remove the resistor, as it will be dissipating some 36W.

RV2 sets the low voltage drop-out of the supply on the comparator IC2. With no battery connected, the voltage across the supply of IC2 should be 13.8V, adjust RV3 until this is so. Monitor the voltage across the pins 2 (positive) and 3 (negative) of IC2 and adjust RV3 until the voltage is at 1.5V. This will have set the drop out voltage to 11.0V and at this point the battery will have been discharged to 30% of it's full capacity.

RV3 sets the output voltage, which is set to 14.4V at the battery's terminals. There should be less than 13.8V on the main output to the transceiver and at least 12.5V.

Use of the Power Supply

The power supply as previously mentioned was originally designed to run a three port packet node. The circuit can however be used to run in a single TNC and transceiver combination with very few modifications. These would only be to actual component values in the circuit.

The capacity of the storage battery in the power supply is dependent on two factors, the first of which is related to the amount of backup required in the event of a power failure. It is also dependent on the total current drain from the power supply. For example, if the transceiver were disconnected from the supply and the battery remained connected, the maximum charging current would remain at 3.0A. For a gel cell battery, as used here, a maximum charging current of 3.0A relates to a minimum battery capacity of 12A/H. The maximum charging current is a quarter of the Amp Hour capacity in the type of battery used in the prototypes, but according to one manufacturer, Yuasa, it is quite in order to charge a gel cell at twice the current of it's Amp/Hour capacity, which means that a 1.5A/H gel cell can be used. This will result in a 20% reduction in the life of the battery if this is done often, would have little effect on the overall life of the battery as this charging rate would be a rare occurrence. A 12V 3A Hour battery would be most suitable for this unit. In the case of a single TNC/transceiver combination, the charging current (current limit), when the transceiver is disconnected, can be reduced to 1.5A or even 1.0A, thereby reducing the size and cost of the storage battery needed. There need only be one component change and this involves a new selection for R3.

For a limiting current of 1.0A, R3 can be changed to 1R0. For a higher current of 1.5A, R3 will stay as in the modified case above at 1R0. The adjustment can be accommodated for the additional current with the preset RV1. This will therefore change the size of battery needed and the cost and size of the enclosure required. Limiting the current to 1.0A charging current will need a 12V 4A hour battery, 1.5A will need 6A hours.

One further thought on the construction of the power supply should be considered if the storage battery is built within the same enclosure as the rest of the electronics. A simple battery On/Off switch should be incorporated in series with the positive line to the battery. This will enable the battery to be isolated from the rest of the circuit in the event of the unit being switched off from the mains supply for any appreciable length of time, which may discharge the battery.

Using the Power Supply

Firstly, the power supply is connected to the mains and switched on and the battery is connected to the unit, if it is external. The mains neon will illuminate on the front panel, but the power led LED1 will remain unlit until the push button S2 is momentarily pressed. This should not be done unless either the battery is in a fully charged state, or the supply has been allowed to charge the battery for at least two hours. This should give the battery time to actually get some charge in it before it is used. Press S2 and the relay RLA will energise, causing the contact to be made between the battery and the transceiver. The relay will remain energised if the battery is in a good state, otherwise it will de-energise as the storage battery will need tend to take all current in charging.

Conclusions

The unit has been in operation since March this year and shows no signs of deterioration. The main problem associated with this type of PSU incorporating a storage battery, is that batteries need some form of exercise, rather like you and I. They need to be cycled often to maintain their efficiency and this design keeps the battery float charged and cycled throughout use, as the extra current demanded on transmit is enough to cycle the battery, with the float charge part of the circuit keeping it in top condition.

This power supply has replaced a 12V 30A switch mode power supply, which can now be put to other uses. There seems to be no apparent change in performance of the equipment and the after some time in use, I have seen no problems with the storage capacity of the battery, which was always a worry.

PARTS LIST

RESISTORS

R1 2k2 1/2W
R2 2k7 1/4
R3 0R47 2.5W wirewound
R4 820R
R5 6k8
R6 1R5 2.5W wirewound
R7 3k9
R8 68k
R9 220R
R10 1k8
R11 1k0
RV1 1k0 horizontal preset
RV2 5k0 horizontal preset
RV3 1k0 horizontal preset

CAPACITORS

C1 100n 250V AC RMS working
C2 100n ceramic
C3 4700µ 50V 10mm pitch pc mounting electrolytic
C4 4700µ 50V 10mm pitch pc mounting electrolytic
C5 47µ 25v axial electrolytic
C6 4µ7 25v axial electrolytic
C7 47µ 25v axial electrolytic

SEMICONDUCTORS

IC1 LM317T 1.5A adjustable regulator, plus insulating kit
IC2 LM741N opamp

Q1 TIP142, plus insulating kit
Q2 ZTX300
Q3 TIP34A, plus insulating kit
Q4 ZTX650
BR1 200V piv 4A pc mounting bridge rectifier 0.2" pitch
D1 4V7 500mW zener diode
D2 1N4148 signal diode
D3 BYW80-150 fast recovery diode, plus insulating kit
D4 MBR20100 20A diode
LED1 0.2in 10mA, green LED

MISCELLANEOUS

LP1 240V mains neon indicator, with internal resistor
RLA 12 volt coil, 30A contact SP relay. RS stock no. 351-768
F1 500mA 20mm anti-surge fuse and chassis holder
F2 3.15A 20mm fuse and PC mounting holder
F3 15A 1 1/4" fuse and chassis holder

BAT1 12V 15A/H gell cell battery (used in prototype), 3AHcapacity battery can be used can be used as an alternative. T1 240/15V 100VA mains transformer
SW1 240V 3A mains switch, DPDT
SW2 Push button switch (momentary), push to make
Case, bracket fabricated from aluminium sheet for heatsink, connecting wire, mica washer insulating kits, connectors, 3R3 25W resistor (test purposes only), etc.

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Price code	Price (inc. VAT)
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D	£2.50
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F	£4.00
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PCBs for the remaining projects are available from the companies listed in Buylines.
Use the form or a photocopy for your order. Please fill out all parts of the form. Make sure you use the board reference numbers. This not only identifies the board but also tells you when the project was published. The first two numbers are the year, the next two are the month.
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E9201 -5	Enlarger Timer Selector Board (2 sided)	K
E9201-6	Enlarger Timer Switch PCB	E
E9203-1	MIDI Switcher- Main Board	L
E9203-2	MIDI Switcher- Power Suply	E
E9203-3	Sine Wave Generator (surface mount)	F
E9204-1	Auto Car Lights	F
E9205-1	Bat Detector	E
E9205-2	Pond Controller	F
E9206-FC	Stereo amplifier	G
E9206-2	Xenon flash trigger Main Board	J
E9206-3	Xenon flash trigger Flash Board	F
E9206-4	Scanner for audio generator	D
E9207-1	Improved Rear Bike Lamp	D
E9207-2	Mini Baby Bug Monitor	C
E9207-3	Ultrasonic Audio Sender (2 boards)	H
E9207-4	Camera Add-on unit (4 boards)	O
E9207-5	AutoMate 5V/48V Mixer power supply	J
E9207-6	AutoMate Precision 17V power supply	J
E9207-FC	Surround Sound Decoder	F
E9208-1	Dynamic Noise Limiter	F
E9208-2	Touch Controlled Intercom (2 boards)	H
E9208-3	MIDI Keyboard	K
E9208-FC	Battery charger	F
E9209-1	Intercom for light aircraft	H
E9209-2	Alarm protector	C
E9209-3	Temperature controller	M
E9209-FC	45W Hybrid power amp	F
E9210-1	Universal I/O Interface for PC (2 Sided)	N
E2910-2	Rapid Fuse Checker	E
E9210-3	Heartbeat/Audio Listener	E
E9210-FC	Wizards Hat	E
E9211-1	Electronic Die	E
E9211-FC	Car Alarm	F
E9212-1	Digital Circuit Tester	F
E9212-2	Communications Link by RS232	L
E9212-FC	Mains Inverter	E
E9301-2	Fading Festoonery	G
E9301-FC	Infra Red Receiver	F
E9302-1	EPROM Programmer (2 Sided)	N
E9302-2	Sound to MIDI Board	L
E9302-3	Puddle Tec	E
E9302-4	DiscoAmiga Light Selector	H
E9302-FC	Infra Red Transmitter	E
E9303-1	Ni-Cd Battery Charger	E
E9303-2	IC Tester	E
E9303-3	Disco Amiga (motor driver board)	H
E9303-4	Direct Conversion Reciever (2 Sided)	N
E9303-FC	LED Stoboscope	F
E9304-1	Solo Mic Pre-Amplifier	F
E9304-2	Multimate Tester	C
E9304-3	The Keepsafe Alarm	F
E9304-4	Proving Unit	E
E9304-5	Infra Guide Receiver Module	C
E9304-6	Infra Guide Transmitter	F
E9304-FC	(AutoMate) Peak Program Meter	F
E9305-1	Pentacode Main Board	F
E9305-2	Pentacode Relay Board	F
E9305-4	Vibration Detector	D
E9305-FC	The Fuzztone	E
E9306-1	Graphic Equaliser	F
E9306-2	Super Spooker	H
E9306-3	Middle & Side Stereo Coding	D
E9306-FC	The Chaperon	F
E9307-1	Car Battery Tester (Double Sided - Surface Mount)	E
E9307-2	Mind Trainer	F
E9307-FC	Microwave Monitor	F

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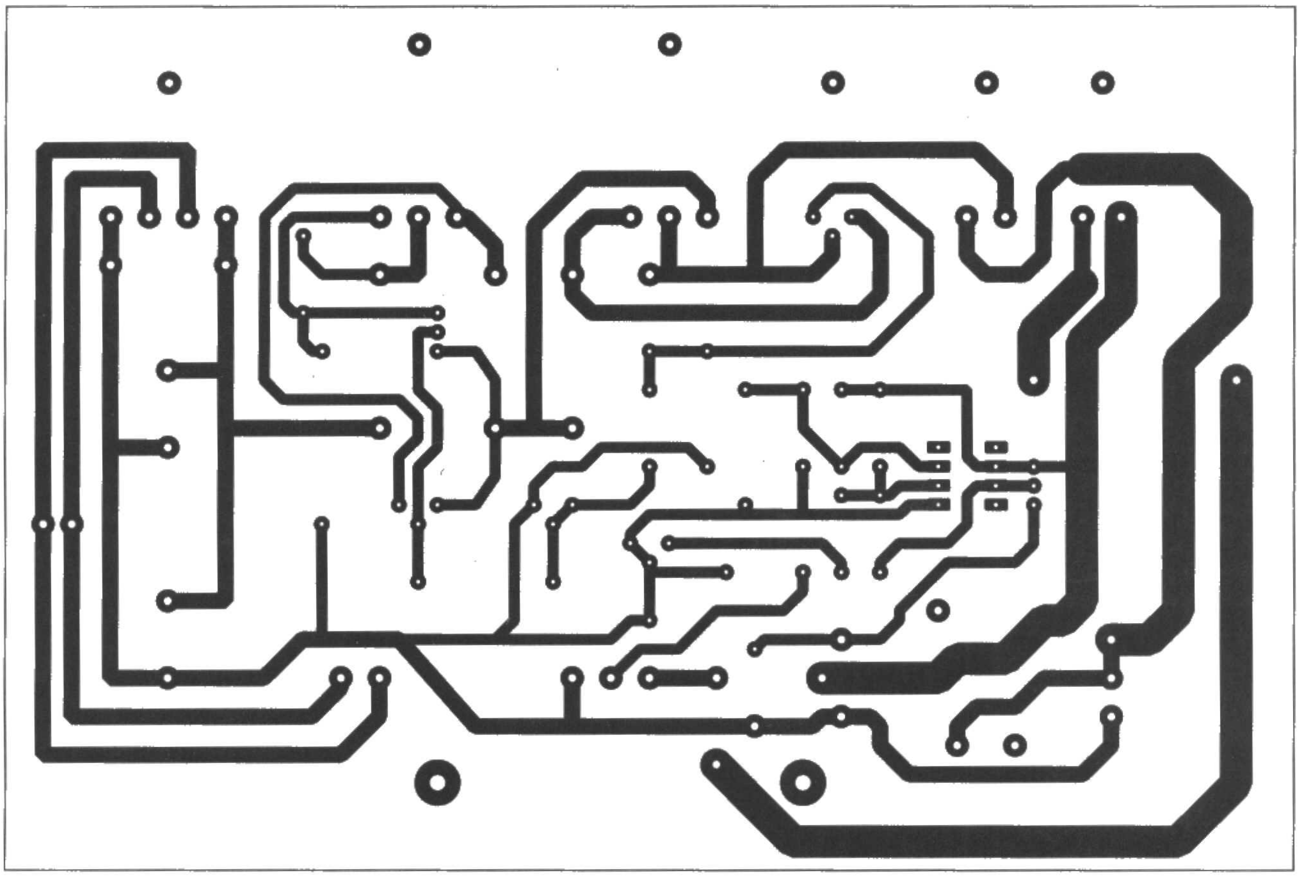
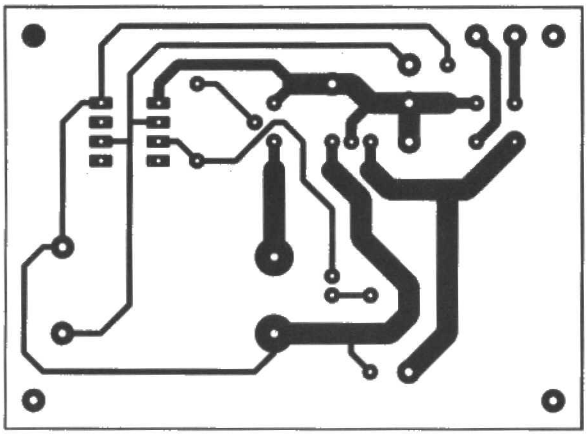
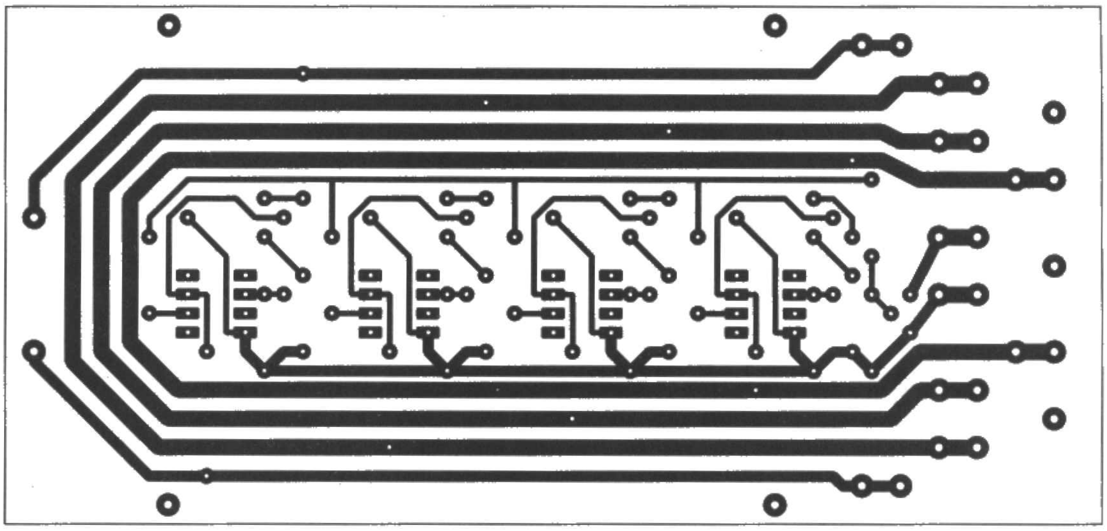


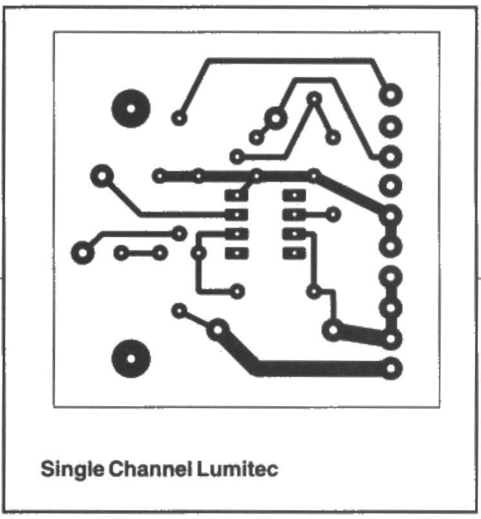
Alternative 12V PSU



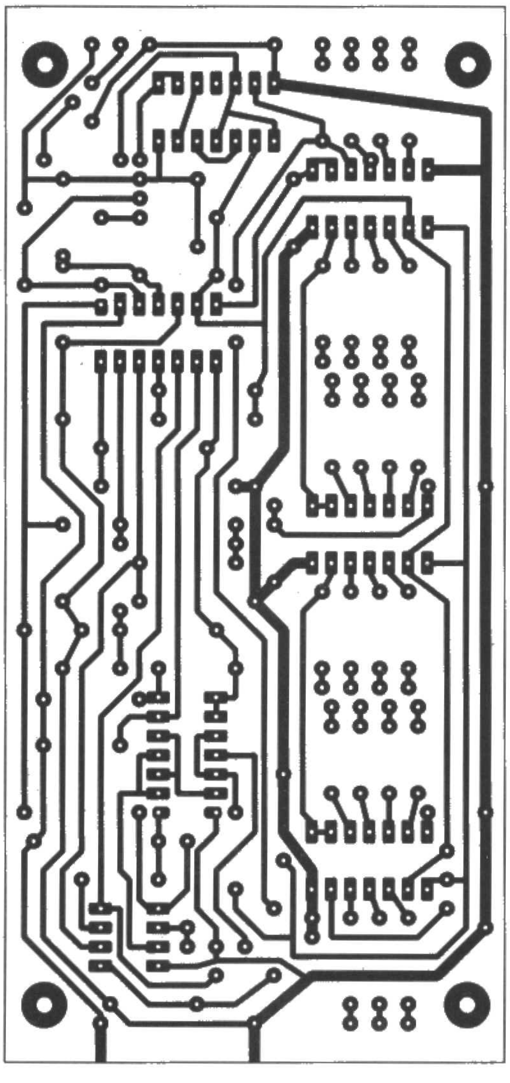
Twi-light Zone



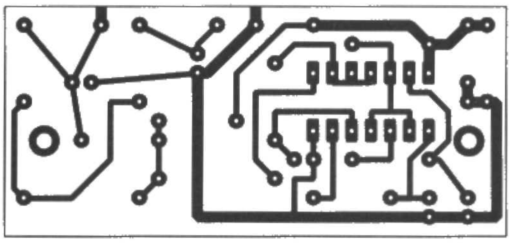
4 Channel Lumitec



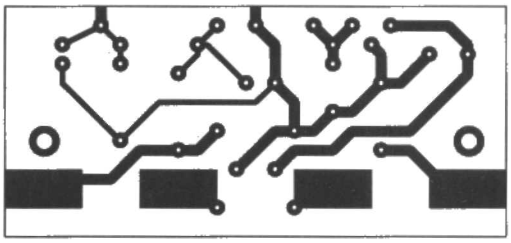
Single Channel Lumitec



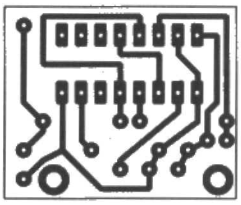
Window Monitor



Battery PSU Board



Mains PSU Board



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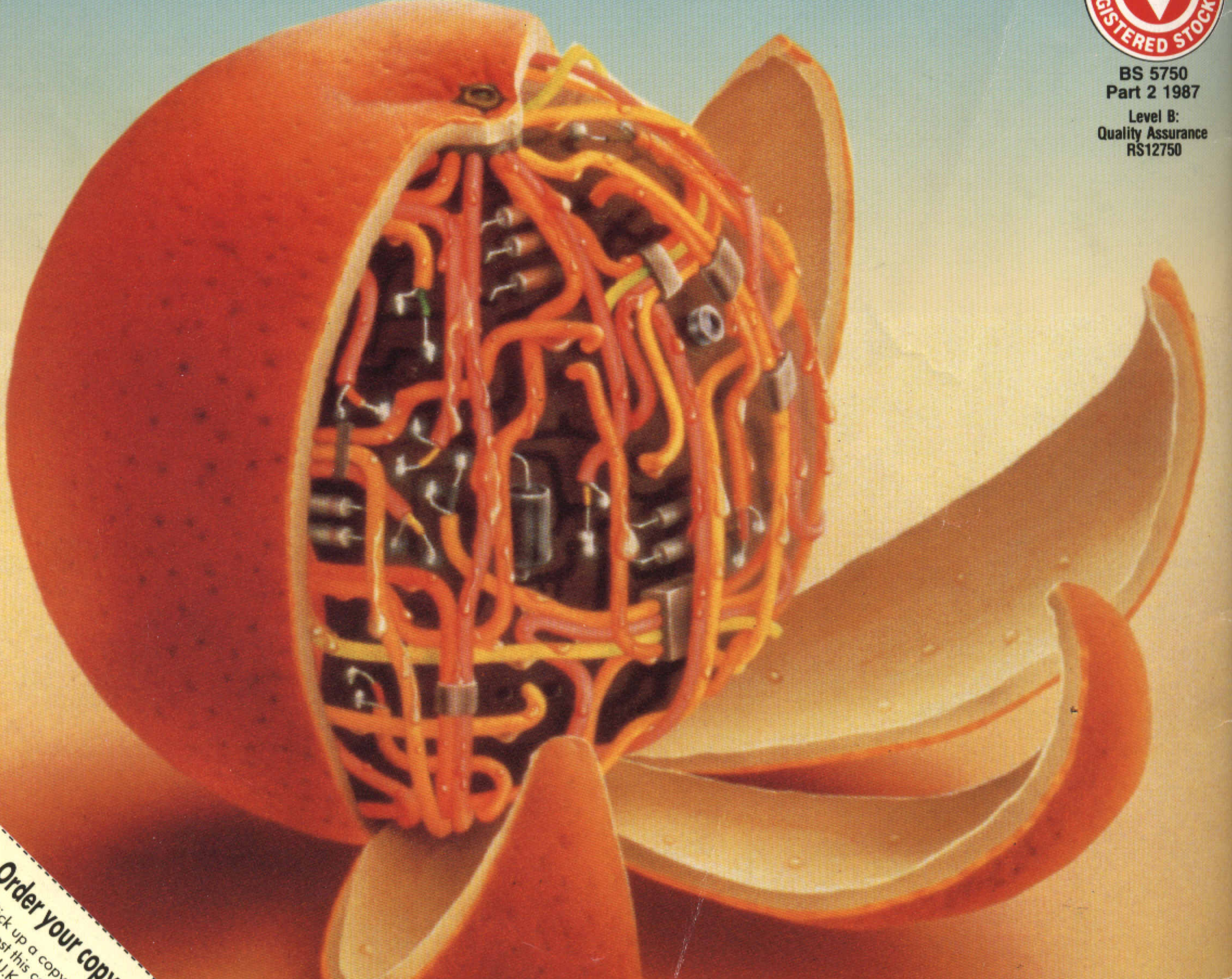

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